Wireless World

RADIO AND ELECTRONICS

Vol LVI No 9 Two Shillings September 1950

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The instrument consists basically of a balanced bridge valve voltmeter. It incorporates many unique features and a wide set of ranges, so that in operation it is as simple to use as a normal multi-range testmeter. Gives 56 ranges of readings:

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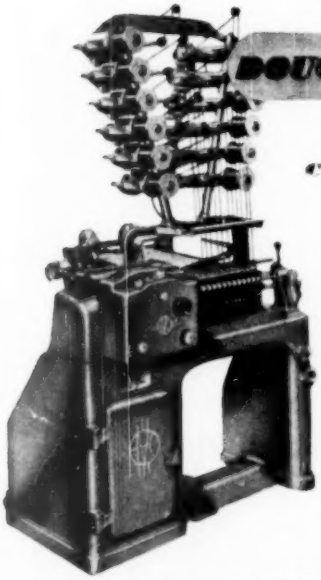
See 'AVO' Instruments at THE RADIO SHOW Stand No. 26



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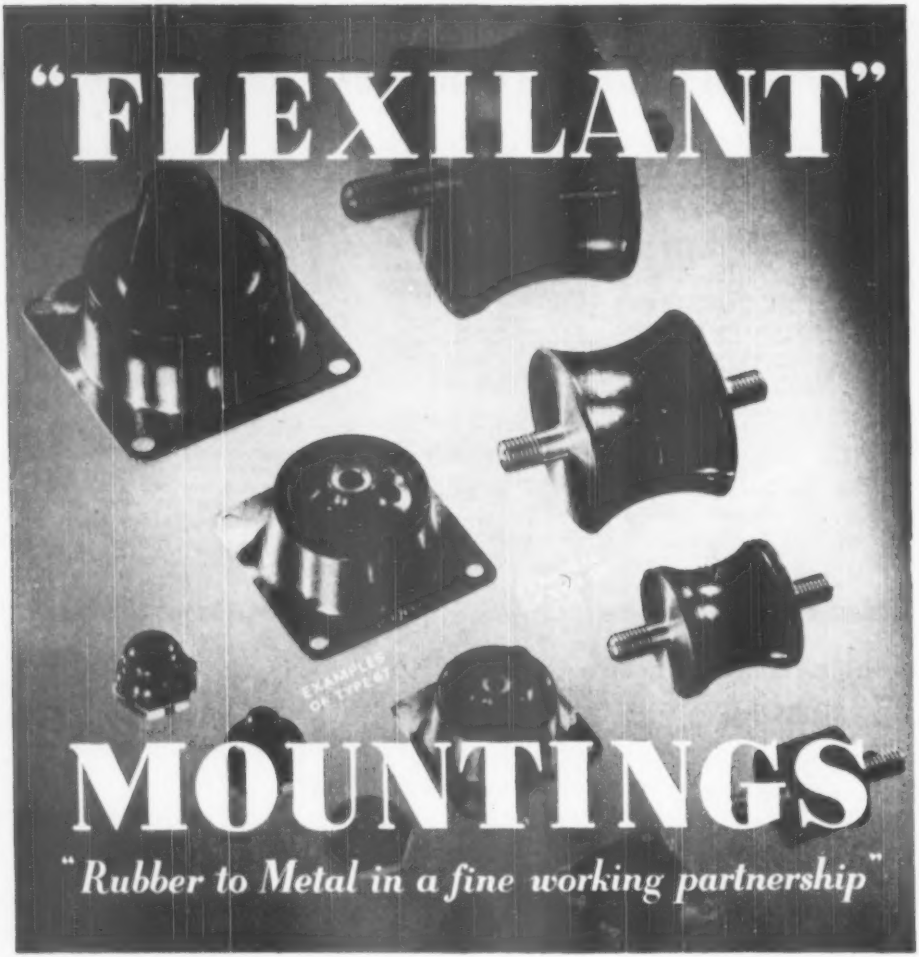

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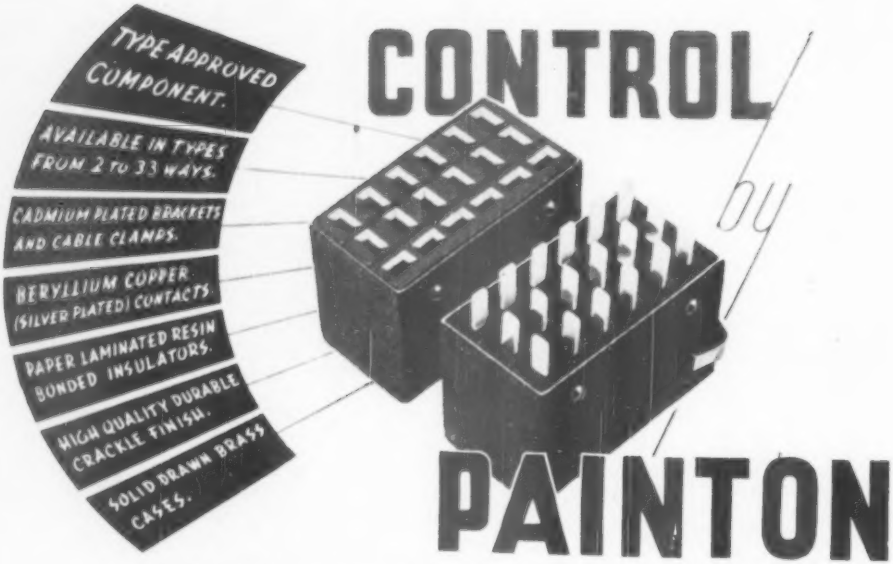

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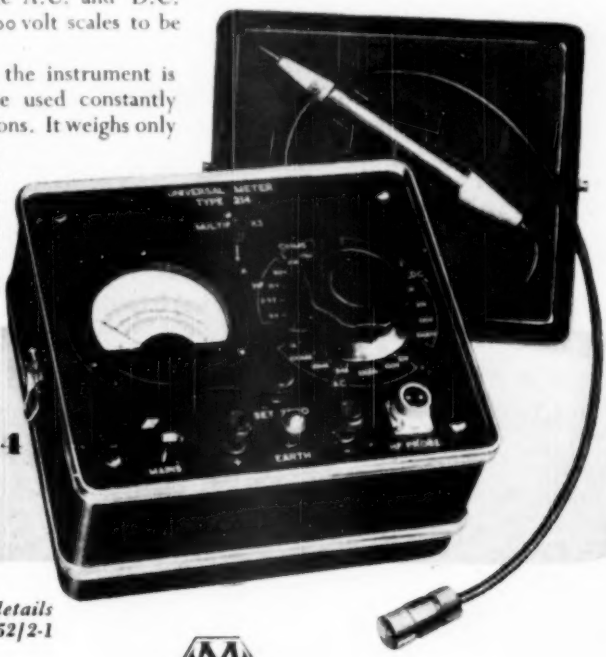

TYPE 214

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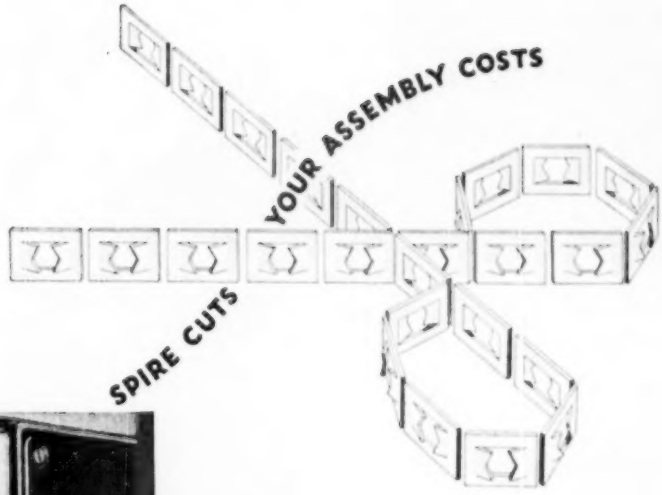

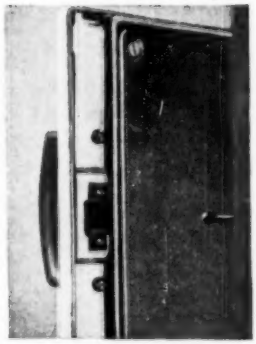

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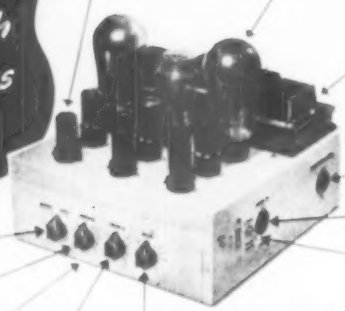

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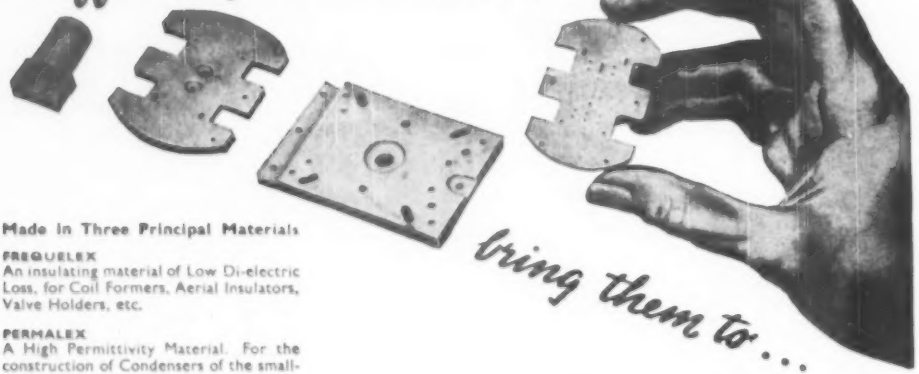

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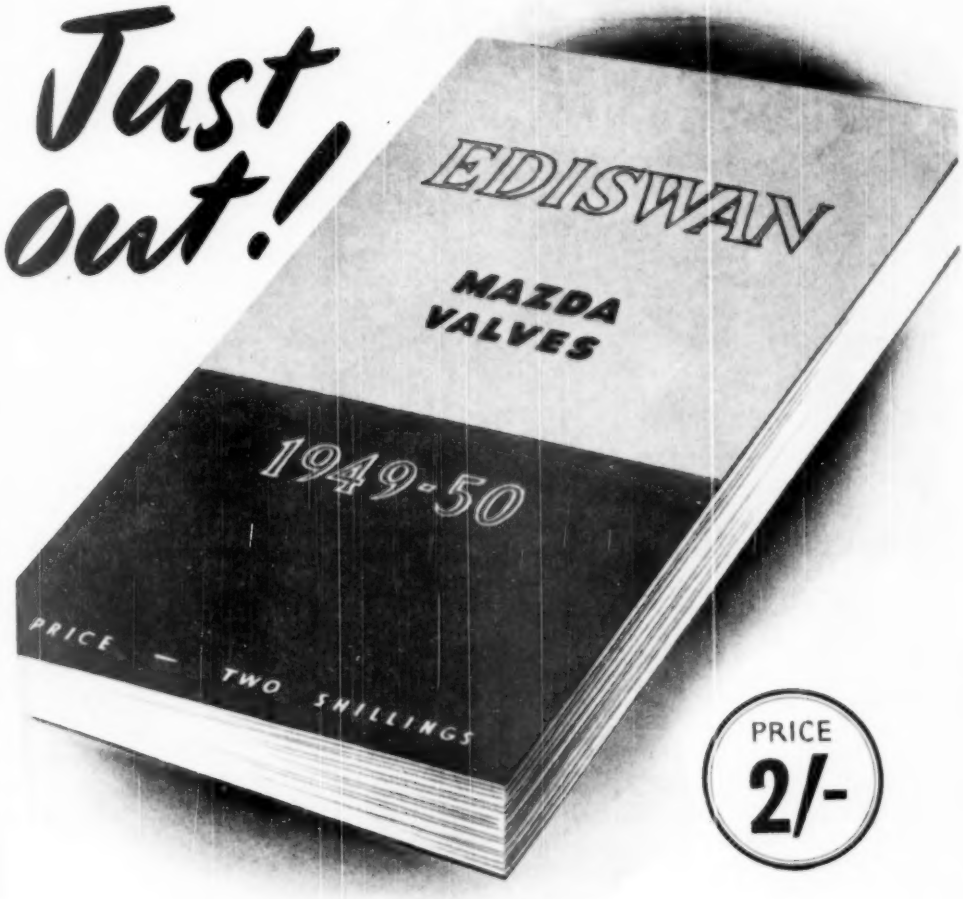

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★ *This booklet is a condensed version of the Ediswan Loose-leaf Valve Manual and supplements the 1948-49 edition. A few copies of the 1948-49 edition are still available, price 1/4d., including postage.*

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KV220

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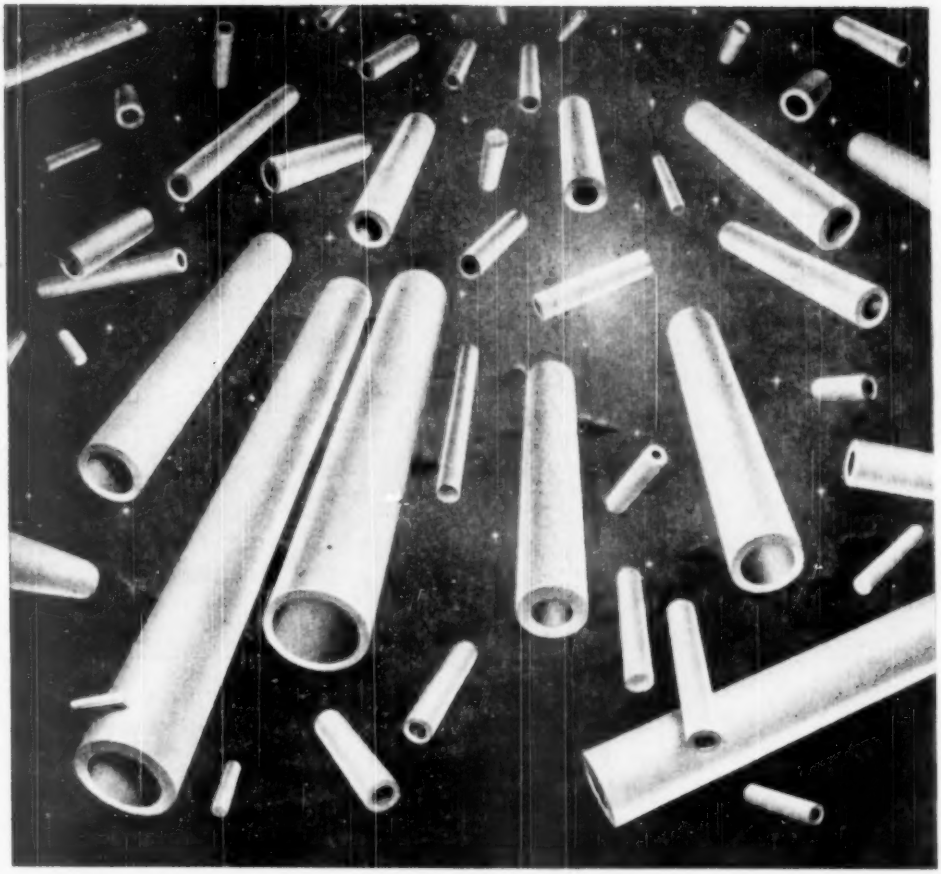

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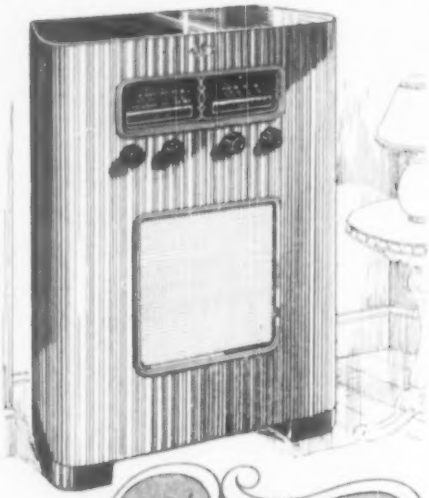

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JOVE
AND HIS LIGHTNINGS

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Olympian might made visible to mortal man, that he may know the majesty and awful wrath of gods.

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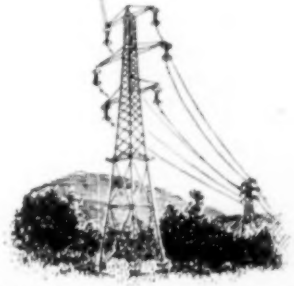

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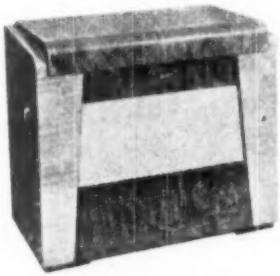

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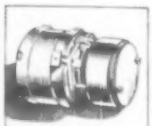

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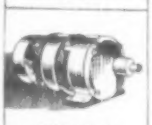

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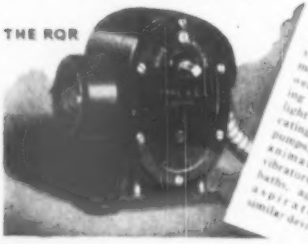

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230/200/110-A	100/120 v.	200/250 v.	100/200	£14 0 0
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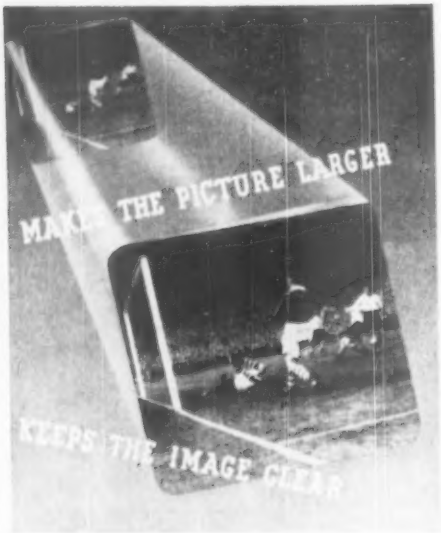

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20AV	B8G	150	10	0.05	45	—
20CG	B8G	90	5	0.1	150	10
20CV	B8G	250	20	0.05	25	—
90AG	B7G	90	2.5	0.1	200	7
*90AV	B7G	100	5	0.05	45	—
*90CG	B7G	90	2	0.1	125	10
*90CV	B7G	100	10	0.05	20	—
58CG	Wire-in	90	1.5	0.1	85	9
58CV	Wire-in	100	1.5	0.05	15	—

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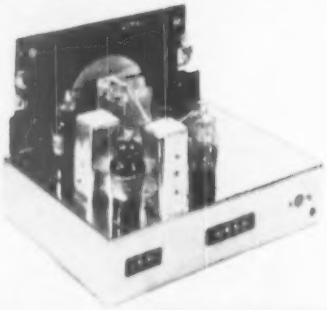

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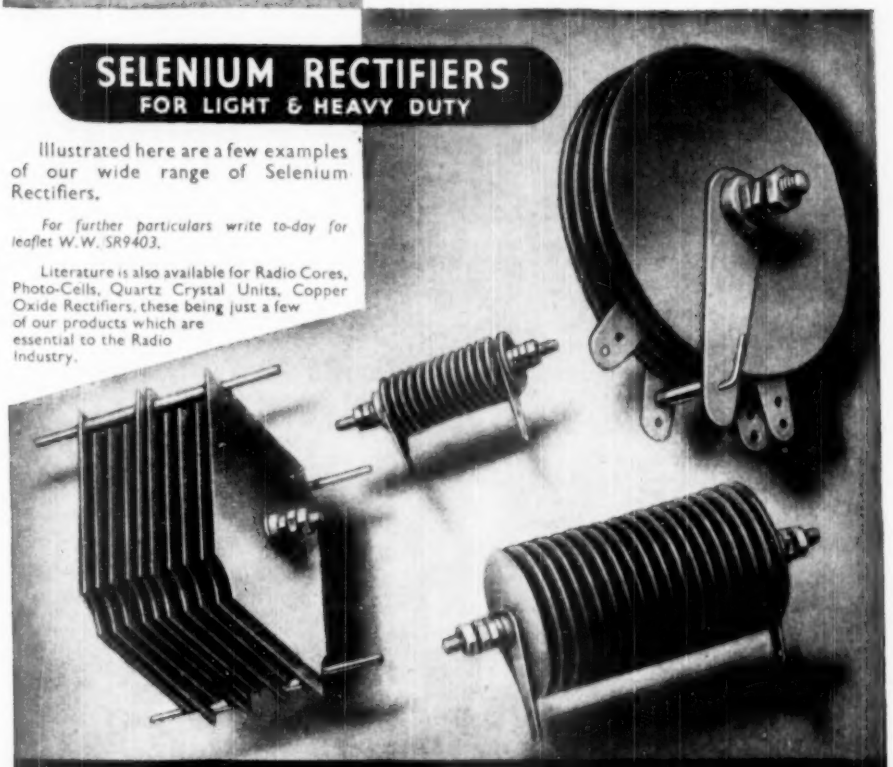

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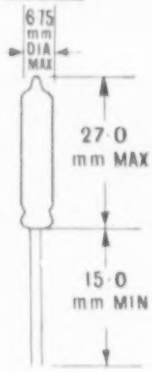
Cold Cathode Diode

NT 2



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Maximum power dissipation	0·06 W.
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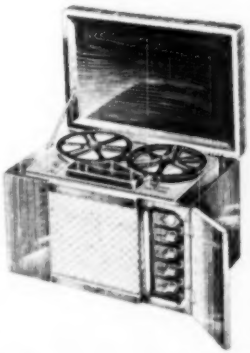

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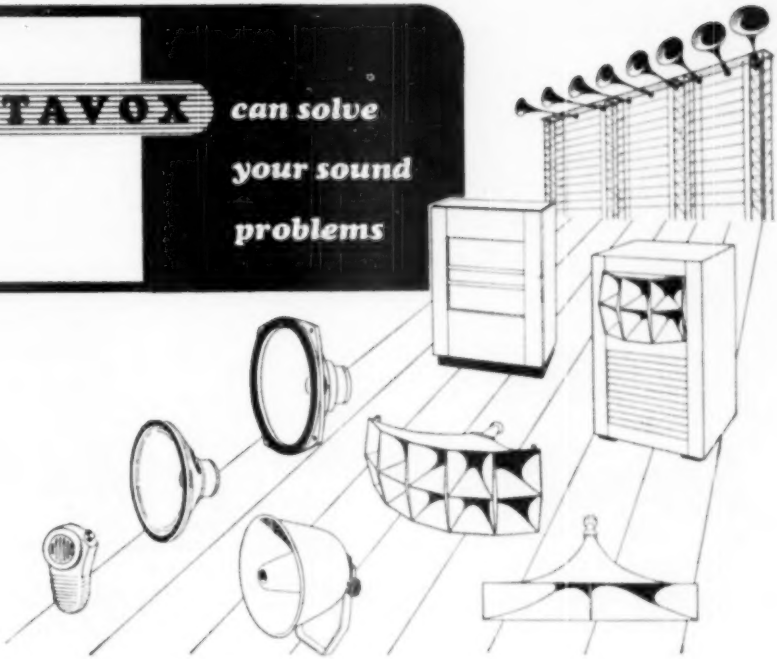

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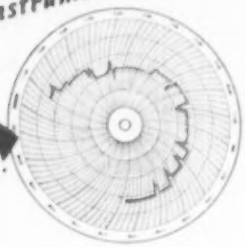

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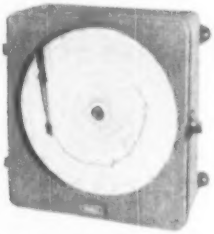
Movements available from 50 micro-amps. or 15 millivolts upwards.



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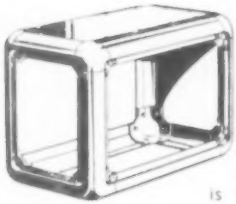

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£19. 19. 0. (Carriage & Packing 15/-) *including all parts, valves and loud speaker, but excluding* CR TUBE

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The Vision Receiver consists of 4 R.F. stages (EF54's) which are followed by a Diode Detector and Noise Limiter (6H6) which is directly coupled to the Video valve (EF54).

Complete Kit with valves, **£3 16 0.**

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The Sound Receiver comprises 3 R.F. stages (6SH7's) followed by a Double Diode Triode (6Q7), which acts as Detector and L.F. Amplifier. A Noise Limiter (EA50) is also incorporated. The output valve (6V6) drives a 10in. P.M. Moving Coil Speaker with closed field magnet, which is included in the Time Base Kit.

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The Time Bases employ blocking oscillators on both line (6SH7 and 807), and Frame (VR137 and 6V6). E.H.T. (non-lethal) is taken from the Line Output Transformer through a voltage doubler employing two valves (VU111). The Sync separators are 6H6 and 6V6. Permanent Magnet Focusing.

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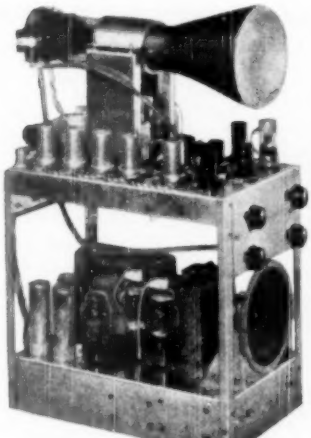

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As is usual in all Premier Kits, every single item down to the last Bolt and Nut is supplied. All chassis are punched and layout diagrams and theoretical circuits are included.

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This unit includes the VCR97 Tube, Tube Fittings and Socket and a 6in. P.M. Moving Coil Speaker with closed field for Television. The instruction book costs **2/6**, but is credited if a Kit for the complete Televisor is purchased.

Any of these Kits may be purchased separately; in fact, any single part can be supplied. A complete priced list of all parts will be found in the instruction book.

20 Valves are used, the coils are all wound and every part is tested. All you need to build a complete Television Receiver is a screwdriver, a pair of pliers, a soldering iron and the ability to read a theoretical diagram.

The following sensitivity figures prove that the Premier Televisor Kits are capable of reception at greater distances than any other standard commercial kit or receiver whether T.R.F. or Superhet.

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Sensitivity	25μv for 15 v. peak to peak measured at the Anode of the Video Valve
Sound Rejection	Better than 40 db.
Adjacent Sound Rejection	Midland Model. Better than 50 db

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Sensitivity	20μv. Vision Rejection better than 50 db.

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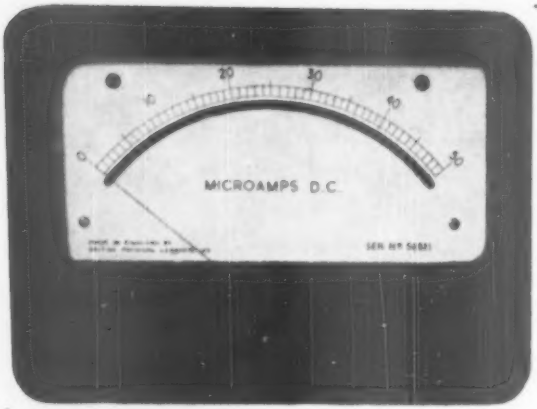

SIZE	2½"	3½"	5"
RANGE	25μA to 50A	10μA to 50A	10μA to 50A
PRICE			
50μA	55/-	61/-	93/-
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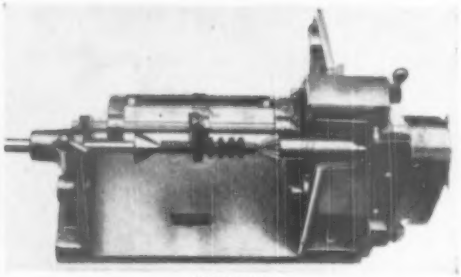

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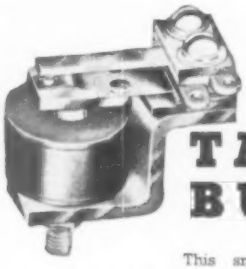

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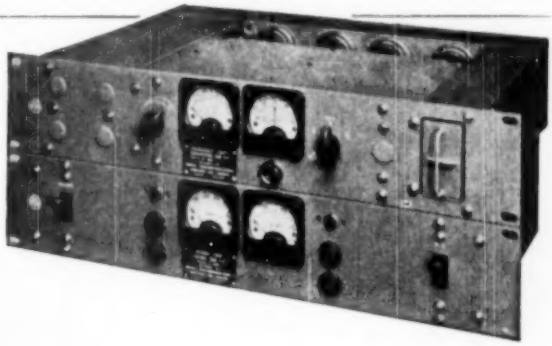
for frequency shift reception



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for frequency shift keying

These units can be fitted on site by station engineers, any modification of radio equipment necessitated being only of a minor nature.

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HS40. Windings as above. 4v. at 4 amps. 4v. at 2 amps. Output	15/6
HS2. 250/0/250v. 80 m/a.	17/6
HS30. 300/0/300v. 80 m/a.	17/6
HS3. 350/0/350v. 80 m/a.	17/6
HS2X. 250/0/250v. 100 m/a.	19/6
HS75. 275/0/275v. 100 m/a.	19/6
HS30X. 300/0/300v. 100 m/a.	19/6
HS3X. 350/0/350v. 100 m/a.	19/6

Fully Shrouded

PSM61. (Midget) Output 250/0/250v. 60 m/a. 6.3v. at 3 amps. 5v. at 2 amps.	15/6
PS2. 250/0/250v. 80 m/a.	19/6
PS30. 300/0/300v. 80 m/a.	19/6
PS3. 350/0/350v. 80 m/a.	19/6
PS2X. 250/0/250v. 100 m/a.	21/6
PS75. 275/0/275v. 100 m/a.	21/6
PS30X. 300/0/300v. 100 m/a.	21/6
PS3X. 350/0/350v. 100 m/a.	21/6

All the above have 6.3-4.0v. at 4 amps., 5-4.0v. at 2 amps.

PS41. Output, 425/0/425v. 200 m/a. 6.3v. 4 amps. C.T. 6.3v. 4 amps. C.T. 5v. 3 amps. Fully shrouded	42/6
PS50. Output, 450/0/450v. 250 m/a. 6.3v. 2 amps. C.T., 6.3v. 4 amps. C.T. 5v. 3 amps. Fully shrouded	62/6
P30X. Output, 300/0/300v. 80 m/a. 6.3v. 7 amps. 5v. 2 amps. Framed, Flying leads	26/6
P35X. Output, 350/0/350v. 250 m/a. 6.3v. 6 amps. 4v. 8 amps., 4v. 3 amps., 0-2-6.3v. 2 amps. Fully shrouded	59/6
PS160X. Output 350/0/350v. 160 m/a., 6.3v. 6 amps. 6.3v. 3 amps. 5v. 3 amps. Fully shrouded	37/6
PS43X. Output, 425/0/425v. 250 m/a. 6.3v. 6 amps. 6.3v. 6 amps. 5v. 3 amps. Fully shrouded	57/6
HS6. Output, 250/0/250v. 100 m/a. 6.3v. 6 amps. C.T. 5v. 3 amps. For receiver R1355. Half shrouded	24/6
HS150. Output, 350/0/350v. 150 m/a., 6.3v. 3 amps. C.T. 5v. 3 amps. Half shrouded	25/9
F36. Output, 250/0/250v. 100 m/a. 6.3v. 6 amps. C.T. 5v. 3 amps. Half shrouded	25/9
FS120. Output, 350/0/350v. 120 m/a. 6.3v. 2 amps. C.T. 6.3v. 2 amps. C.T. 5v. 3 amp. Fully shrouded	27/6
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The above have inputs of 230/250v.

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F12. Output, 12.6v. tapped 6.3v. at 3 amps.	15/6
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F12 and F24 framed with Flying Leads.	
FU6. Output, 0-2-4-5-6.3v. at 2 amps.	9/-
F29. Output, 0-2-4-5-6.3v. at 4 amps.	15/-
FU6 and F29 clamped with Flying Leads.	
F5. Output, 6.3v. at 10 amps. or 5v. at 10 amps. or 12.6v. at 5 amps. or 10v. at 5 amps.	31/6
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3 Because of (2) it is the only amplifier which can be used successfully with a very wide range loudspeaker if 'average' as well as 'picked' recordings are to be played.

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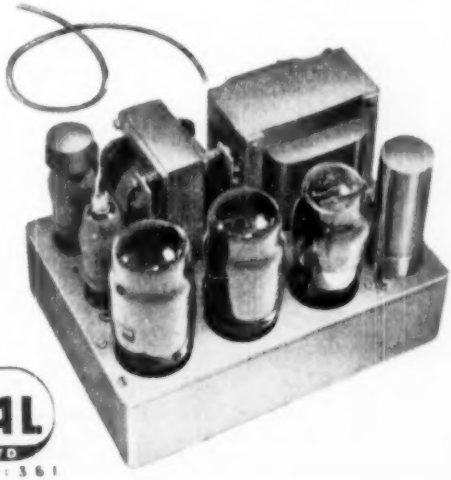
5 Day-by-day adjustments are confined to programme quality and volume controls, a procedure which is both simple and accurate.



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Type Q.U.A.D. 12 watt quality amplifier for A.C. mains. **£33**

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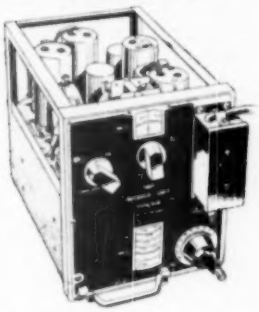

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Mallory Type 650. 6v. 4 pin American base **7 6**

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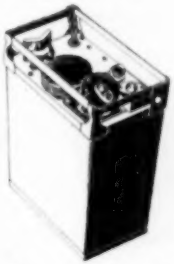

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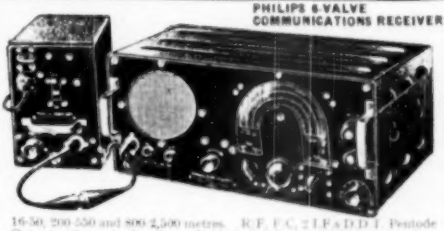

16-50, 200-550 and 800-2,500 metres. R.F. F.C. 2 I.F.s D.D.T. Pentode Output. Spin-wheel tuning. In black metal case with built in speaker. Complete with power pack. AC 200-250v. Can also be supplied with 12v. D.C. power pack if required. BRAND NEW EX GOVT. **£16.10.0**

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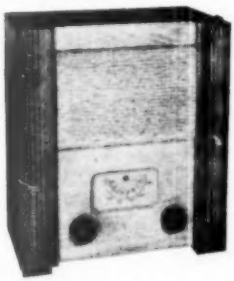

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- Carriage charges relate to British Isles only.

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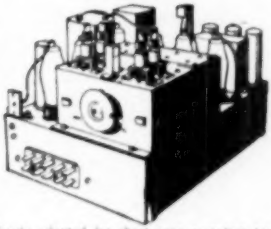

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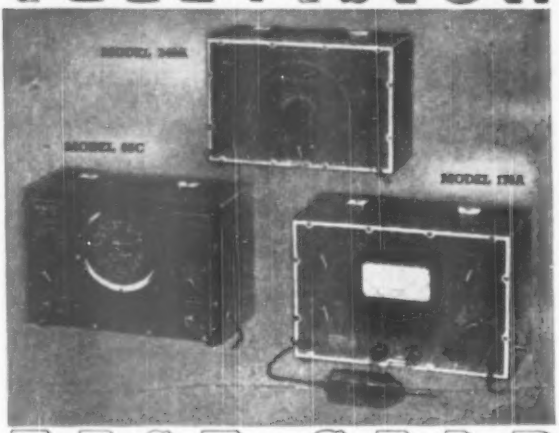

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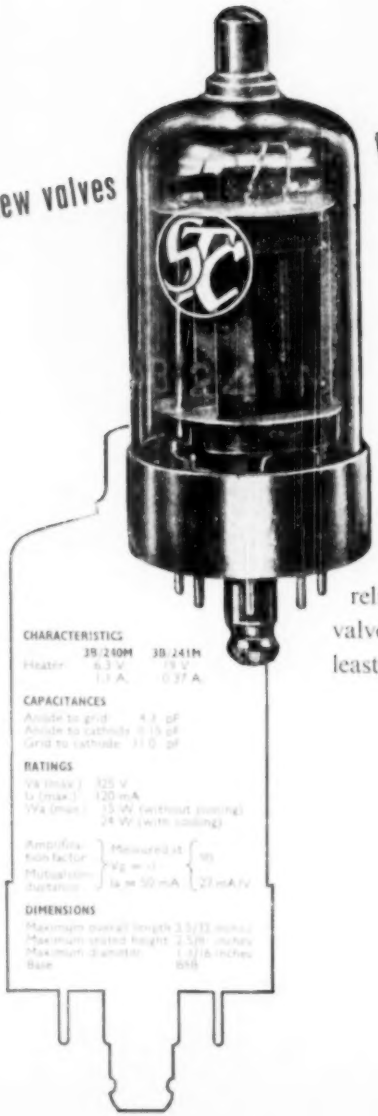

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Wireless World

RADIO AND ELECTRONICS

September 1950

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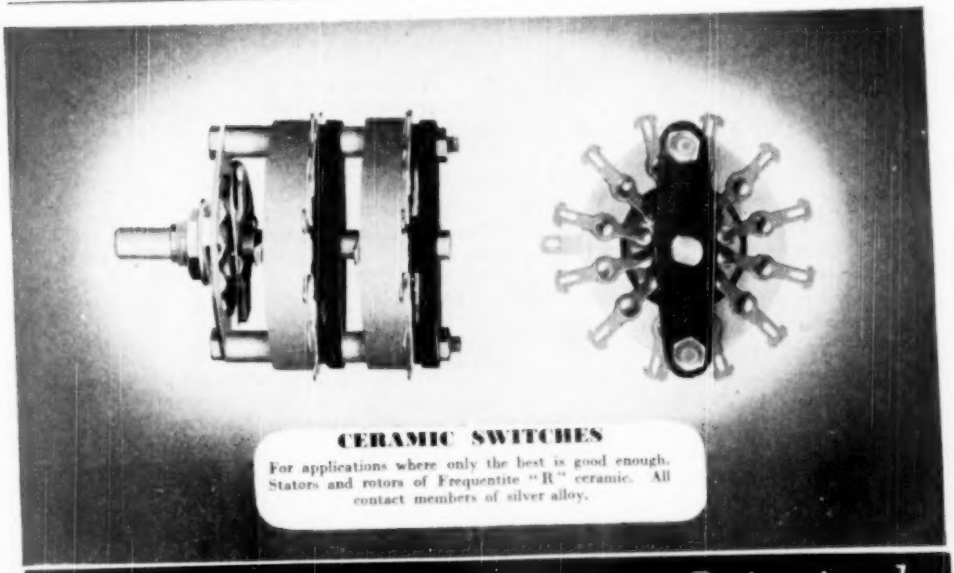
In This Issue

EDITORIAL COMMENT .. 305
17th NATIONAL RADIO EXHIBITION .. 306
FLYBACK E.H.T.—2. By *W. T. Cocking* .. 313
WORLD OF WIRELESS .. 316
MEASUREMENTS WITH SIMPLE APPARATUS. By *Donald Robinson* .. 320
AIR TRAFFIC CONTROL .. 323
NEW BOOKS .. 324
GRAMOPHONE SPEED CONVERSION. By *R. L. West* .. 325
IMPROVED STEREOPHONY. By *E. Aisberg* .. 327
SHORT-WAVE CONDITIONS. By *T. W. Bennington* .. 330
R.C. OSCILLATORS. By "*Cathode Ray*" .. 331
MONITORING AIRWAYS RADIO .. 335
UNBIASED. By "*Free Grid*" .. 336
LETTERS TO THE EDITOR .. 337
RANDOM DIATIONS. By "*Diallist*" .. 340



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Important trends in VALVE DESIGN

MULLARD TELEVISION H.F. PENTODE TYPE EF80

The main application of the EF80 is as R.F. or I.F. amplifier in television receivers. It is, however, suitable for use also as a video output valve, as a synchronising pulse separator and as a frequency changer. In order to meet the requirements of the latest trends in receiver practice, and particularly the trend to use the transformerless technique for D.C./A.C. operation, the valve has been designed to give adequate performance when operated from a 170 V high tension line. The EF80 is a miniature R.F. pentode of all-glass construction. The adoption of the Noval (B9A) base with its extra pin connection permits the use of two cathode leads, as a result of which the input conductance is greatly reduced—a point of considerable importance at the higher television frequencies. In the radio frequency stages of receivers for use in the 41.5-65 Mc/s band, and also in the I.F. amplifying stages of superhet receivers operating on the higher television frequencies where intermediate frequencies of the order of 45 Mc/s, are commonly employed, the damping due to the input conductance of the valve is a limiting factor in performance. The low value of input conductance of the EF80 (330 μmhos at 100 Mc/s) renders the valve superior to previous types in this respect.

The following table gives the gains obtainable in a 4-valve amplifier for the following conditions:—

(*a*) Bandwidth 6 Mc/s centred on 45 Mc/s.

(*b*) Bandwidth 3.5 Mc/s centred on 65 Mc/s.

These conditions correspond to Channels 1 and 5 in the British television frequency band, and also represent the most severe conditions under which the valve is likely to be used, either as R.F. amplifier in T.R.F. receivers for the 41.5 to 68 Mc/s band, or as an I.F. amplifier in superhet receivers for higher carrier frequencies.

	Gain (decibels)	
	Amplifier (*a*)	Amplifier (*b*)
Staggered tuned circuits	100	84
Transformer coupled circuits	114	135

For direct-view receivers a gain of 90 db from the aerial terminal to the detector is necessary. It is therefore seen that the EF80 gives ample gain in a 4-valve amplifier at 45 Mc/s using either staggered-tuned single circuits or transformer coupling. At 65 Mc/s, however, transformer coupling must be employed.

RATINGS AND CHARACTERISTICS

HEATER	
V_h	6.3 V
I_h	0.3 A
CAPACITANCES	
c_{in}	7.5 μμF
c_{out}	3.3 μμF
$c_{a\text{-}gl}$	< 0.007 μμF
$c_{a\text{-}k}$	< 0.01 μμF
$c_{gl\text{-}h}$	< 0.15 μμF
CHARACTERISTICS	
V_a	170 V
V_{g2}	170 V
V_{g3}	0 V
I_a	10 mA
I_{g2}	2.5 mA
V_{gl}	-2.0 V
g_m	7.4 mA/V
r_a	0.5 MΩ
$\mu_{gl\text{-}g2}$	50
R_{eq}	1,000 Ω
Input damping (at 50 Mc/s)	12,000 Ω

Mullard

Reprints of this article together with additional data may be obtained free of charge from the address below.

MULLARD ELECTRONIC PRODUCTS LTD., TECHNICAL PUBLICATIONS DEPARTMENT, CENTURY HSE, SHAFTESBURY AVE., W.C.2

MVM 134

Wireless World

VOL. LVI. No. 9. SEPTEMBER 1950

National Radio Exhibition

ECONOMISTS and sociologists tell us that over-centralization is one of the major defects in the organization of our national economy. *Wireless World* is hardly qualified to comment on that matter, but, if it be true, radio must indeed be in a bad way. With remarkably few exceptions, all purely radio manufacture and most industrial development work has long been concentrated in London or at least in a small part of the area known to weather forecasters as "S.E. England." True, as a result of post-war planning of industry a few radio factories have been set up in the North and West, but, rightly or wrongly, they are generally regarded as mere production units working under the direction of a central organization in London.

Now, for the first time, the annual National Radio Exhibition is to be held outside London. This departure from precedent will, we expect, have a salutary effect in showing that appreciation of the finer points of radio design is not confined to the Metropolis. The site of the show at Castle Bromwich is by no means ideal, but at least one of its defects has been overcome by making special arrangements for the transport of visitors from the centre of Birmingham. Consequently a good attendance can be expected.

Although the show is distinctly smaller than last year's Radiolympia—90 exhibitors compared with 172, occupying about two-thirds of the floor space—it is fair enough to call it representative. This is especially true in the field of domestic broadcast and television reception, in which the exhibits will typify fully present-day tendencies and practice. Though television will naturally predominate, few aspects of radio will be entirely unrepresented, except the "heavy engineering" side. In several branches of the art visitors will be able to examine new apparatus and techniques which have not hitherto appeared before the public.

In this issue of *Wireless World* we are publishing a guide to the Exhibition in the form that, we hope, will be found most convenient both to visitors and to others who wish to keep in touch with the present activities of the British radio industry.

Worth-While Tests

OVER two years ago *Wireless World* urged that the B.B.C. should not allow itself to be stampeded into initiating an e.h.f. broadcasting service until all the relevant factors had been investigated by means of a large-scale experiment. Naturally enough, we were highly gratified when the B.B.C. decided that both amplitude and frequency modulation should be tested simultaneously from the same site on high power. These tests have now started.

Although comparative f.m./a.m. tests are not new, we believe that they have not hitherto been conducted with such high power, or on such a favourable basis for comparison.

So far, little information is available as to the precise nature of the tests to be made, and the transmissions are not to a rigidly fixed schedule. No doubt, however, one of the first things to be determined will be the coverage obtainable from a high-power e.h.f. station of modern design, and secondly, to what extent, if any, coverage is dependent on the type of modulation.

Apart from matters mainly connected with transmission, there are many problems which concern the designers of receivers. For example, it has not yet been finally decided if a domestic f.m. set at a strictly economic price can be expected to maintain its alignment sufficiently well for the advantages of f.m. to be fully realized. If only to allow receiver designers to conduct large-scale field tests, a regular schedule of a.m./f.m. transmissions should be started as soon as possible.

17TH National Radio Exhibition

Classified Guide to the Principal Classes of Exhibits

Organized by the Radio Industry Council; Venue, B.I.F. Buildings, Castle Bromwich, Sept. 6-16; Admission, 2/6 (11-5 and all day Sat.), 1/6 (5-10)

PERHAPS it is fitting that Birmingham should be the chosen venue for the first national radio exhibition to be held outside the metropolis, in view of the position it now occupies as the centre of the Midlands television service.

In the following pages the products of the various firms exhibiting are tabulated in a similar manner to that adopted last year as it is believed this serves a very useful purpose by conveying the maximum amount of essential information in a way that is easy to follow. It also enables quick reference to be made when it is desired to trace all the makers of a particular class of equipment.

All the indications are that television will be the dominant feature, but perhaps this was to be expected in view of the recent opening of Sutton Coldfield, and the still further extension of the service in the near future. Indeed some makers of television sets are already catering for additional stations, particularly Holme Moss. In the majority of cases the provision is made as an alternative, effected either by an interchangeable r.f. unit or by suitable pre-set tuning adjustments.

Broadly speaking the television sets fall into three main categories, direct viewing, projection and television combined with all-wave radio. As the tables show direct viewing constitutes the largest class and nearly 40 firms are expected to show models of various kinds. They range from relatively inexpensive table models to quite elaborate consoles.

The popularity of the 9-in tube appears to be waning as, from the information available at the time of going to press, most makers of direct-viewing receivers have adopted the 12-in size as the standard whilst retaining a few 9-in models in order to provide a slightly cheaper set. Large 15-in tubes do not appear to have attracted much support and it is doubtful if more than two or three sets with them will be shown this year.

ALPHABETICAL LIST OF EXHIBITORS AND GUIDE TO THE STANDS

Name	Stand
A.R.B.M.	51
A.T.M.	41
Acrylite (Motor and Air Prods.)	14
Aerialite	75
Air Ministry	19
Alba (Bakelite)	54
Ambassador (Fitton)	68
Amplion	82
Antiference	18
Avo (Automatic Coil Winder)	26
B.C.L.	8
Baird (Symphony)	39
Barclays Bank	6
Belling-Lee	71
B.I. Callender's	80
"Birmingham Gazette"	27
British Railways	107
Brown Brothers	72
Bulgin	3
Bush	48, 103
Champion	73
Concord	5
Cossor	61
Cosser	7, 52
Couplisone	97
"Daily Mail"	89
Derry	22, 57, 49
Dynam	103
Dynatron	69
Econasign	13
Eddystone (Stratton)	83
Edison	33
Ekco (Cole)	11, 53, 92
"Electrical and Radio Trading"	106
Electro Dynamic	9
"Electronic Engineering"	15
English Electric	35
Etronic (Hale)	60
Ferguson	67
Ferranti	55
Fine Wires	101
G.E.C.	38, 77
G.K.N.	29
G.F.O.	21, 34
Garrard	32
Goodmans	85
H.M.V.	12, 65
Holiday	23
Invicta	46
J.B. Manufacturing	98
K.A. (Kimber, Allen)	99
K.B.	36
Kerry's	93
Lloyds Bank	30
McMichael	57
Magnevista (Metro Pex)	78
Marconiphone	51
Masteradio	28
Midland Auto Components	24
Midland Bank	91
Mullard	64, 74
Multicore	86
Murphy	44
National Provincial Bank	108
Peto Scott	84
Philco	38
Philips	42, 45
Pilot	56
Portogram	94
"Practical Wireless"	20
Pye	8, 49
R.G.D.	50
Radiomobile	70
Regentone	66
Romac	88
S.T.C.	43
Scott	104
Sobell	63
Taylor	4
Telcon (T.C.M.C.)	79
Telerection	108
"Television Weekly"	17
Trix	25
Ultra	59
Vidor	47
W.B.	62
Westerman	87
Westinghouse	10
Westminster Bank	75
Winter Trading	96
"Wireless & Electrical Trader"	93
"Wireless World" and "Wireless Engineer"	10
Wolsey	102
Wood	90

One or two makers are using a plastic filter to reduce the effects of ambient light and so enable viewing to be enjoyed in ordinary room lighting. Looked at in ordinary light with the set switched off the tube face has a distinctly dark shade and this has given rise to the description "dark screen" television set. One manufacturer is marketing a light filter as a separate unit.

The second largest category among television sets is the combined broadcast and television receiver. A wide variety of styles will be seen. Some manufacturers have striven to provide in one cabinet all the domestic radio entertainment likely to be desired. For instance, such combinations as an all-wave radio set, automatic electric gramophone having provision for the normal 78 r.p.m. discs as well as long-playing records and projection television.

Nothing very striking is forecast by the advance details in the realm of ordinary broadcast reception. The wider use of miniature valves and, in some cases, components, has led to an all-round reduction in the size of chassis, but this may not be reflected in the external appearance of the set, since the size of the cabinet is largely governed by the loudspeaker.

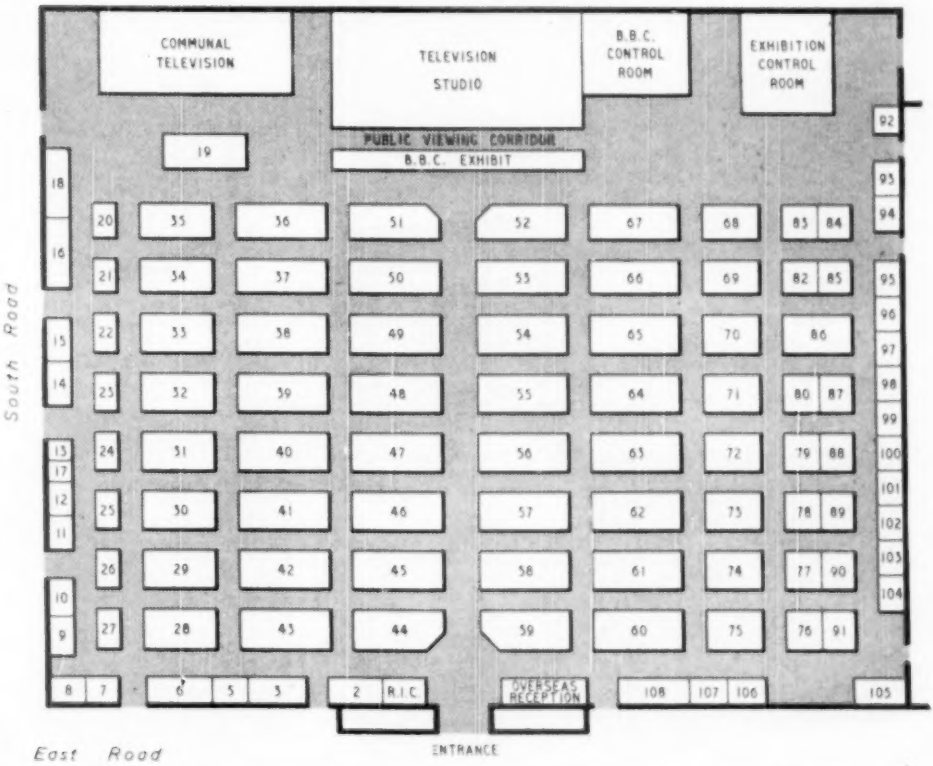
Portables have certainly benefited by the use of miniature parts and the division between ordinary portables and the so-called personal portables is now somewhat indefinite.

Conservation of battery power has come in for more attention and not only are there sets which are either mains or battery driven, but many makers are providing this feature in the form of an optional attachment. Another method of saving battery power is by substituting a small a.c. power unit, which occupies the same space as the battery, when the set is used indoors.

The advent of the long-playing record has had an inevitable repercussion on the design of new gramophone equipment. Almost all the latest radiograms are adaptable for either 78 r.p.m. or 33 1/3 r.p.m. operation and some also for 45 r.p.m. The pick-up has to be changed of course and one firm will be showing a tone arm with interchangeable heads; others use separate pick-up assemblies. These features will be seen embodied in some of the automatic record changers and record playing desks.

Although our classification of equipment is fairly broad it is inevitable that some apparatus will not readily fall within its scope. It must not be taken therefore that every piece of equipment is classified. There will, for instance, be examples of line transmission equipment and coil winding machines.

A noticeable omission at the show will be the lack of what can readily be called the "heavy engineering" side of radio. This is indicated by the scarcity of entries in the section of our tabular matter devoted



to transmitters. Moreover the entries in the section originally devoted to scientific and industrial equipment were so few that it has been omitted.

So far as the non-commercial exhibits are concerned there are three main exhibitors—G.P.O., Air Ministry and B.B.C. To emphasize the importance of a good aerial the G.P.O., who last year received 94,272 complaints of interference, of which over 15,000 were due to poor aerial-earth systems, will be demonstrating the advantage of increasing the height of the aerial and its distance from the house electrical wiring. They will also be demonstrating a 3-cm radio link using a lens-horn aerial. Another exhibit will show how repeaters are used when transmitting television video signals over the ordinary Post Office telephone cable.

The Air Ministry will be featuring a scale model showing how a chain of early-warning radar stations functions. Among the equipment to be seen will be the TR1934 ten-channel v.h.f. set which is the latest radio-telephone transmitter-receiver used by the R.A.F. for both air-to-air and air-to-ground communication. A synthetic radar trainer, used for training controllers in air-to-air interception techniques, will also be demonstrated.

As at Radiolympia, provision is made for visitors to make comparative tests of television receivers in the Hall of Television where 85 sets will be working side by side throughout the greater part of each day. In addition 90 sets will also be in operation on individual stands.

To enable sets to be demonstrated almost continuously and not merely during the normal B.B.C. transmitting hours arrangements have been made to instal a small transmitter working on a closed circuit, which, to avoid interference from Sutton Coldfield, will operate on the Alexandra Palace frequencies. The programmes will include, in addition to B.B.C. transmissions, performances in the exhibition studio, which will be open to the public, and also films.

When the Sutton Coldfield programme is being used it will first be demodulated, passed through a video fader for programme control purposes and will then re-modulate the exhibition transmitter. The film scanner and output from the exhibition studio will be handled via the fader at vision frequency. The wave form will conform to B.B.C. standards.

Broadcast receivers will not be demonstrated at the exhibition.

Ultra "Leader" five-valve a.c. superhet designed for ease of servicing.

The Pilot "Blue Peter" table receiver which covers the trawler band. It is a.c. operated.

The Etronic "Rambler" EPZ4213 mains-battery portable.

The Alba D611 has bandspread tuning on six short-wave bands and it incorporates an automatic record changer.

Built-in aerials for long and medium waves are used in this Ferranti Model 005.

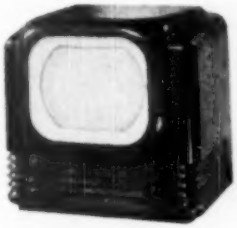
K.B. Model FP11 battery portable (below) with thumb controls.

(Below) McMichael television-broadcast receiver fitted with 12in tube. It has two short-, medium- and long-wave bands.

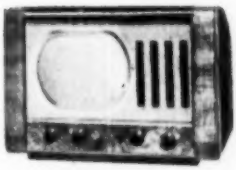
RECEIVERS : Broadcast, Television, Communications and Special Purpose

FIRM	(Stand)	Broadcast: Mains	Battery	Mains battery	Portable	Radio-gramophone	Direct-viewing television	Projection television	Television-broadcast	Special purpose
Alba	(54)	●	●	●	●	●	●	—	—	—
Ambassador	(68)	●	—	●	—	●	●	—	—	—
Amplion	(82)	—	●	●	●	—	—	—	—	—
Baird	(39)	—	—	—	—	—	●	—	●	—
Bush	(48, 105)	●	●	●	●	●	●	—	—	—
Champion	(71)	●	●	●	●	●	●	—	●	—
Co-op	(61)	●	—	—	●	●	●	—	●	—
Cossor	(7, 52)	●	—	●	●	●	●	—	●	—
Decca	(22, 37, 40)	●	—	●	●	●	●	●	—	F
Dynatron	(69)	●	—	—	—	●	●	—	●	—
Eddystone	(83)	●	●	—	—	—	—	—	—	C, Y
Ekco	(11, 53, 92)	●	—	●	●	●	●	—	—	S, M
English Electric	(35)	—	—	—	—	—	●	—	—	F
Etronic	(60)	●	●	●	●	●	●	●	—	—
Ferguson	(67)	●	—	—	—	●	●	●	—	—
Ferranti	(55)	●	●	—	●	●	●	●	●	—
G.E.C.	(58, 77)	●	●	—	—	●	●	—	●	C
H.M.V.	(12, 65)	●	●	—	—	●	●	—	●	F
Invicta	(46)	●	●	●	●	●	●	●	—	T
K.B.	(36)	●	●	●	●	●	●	—	●	—
McMichael	(57)	●	●	—	●	●	●	—	●	T
Marconiphone	(51)	●	●	●	●	●	●	—	—	—
Masteradio	(28)	●	—	●	—	●	●	●	●	M
Midland Auto	(24)	—	—	—	—	—	●	—	—	—
Mullard	(64, 74)	●	—	—	—	—	●	—	—	—
Murphy	(44)	●	●	—	●	●	●	—	—	—
Peto Scott	(84)	●	—	—	●	●	●	●	—	—
Philco	(38)	●	●	●	●	●	●	—	●	—
Philips	(42, 45)	●	●	—	●	●	●	●	—	M
Pilot	(56)	●	—	—	●	—	●	—	—	—
Portogram	(94)	—	—	—	—	●	●	—	—	S
Pye	(8, 49)	●	●	●	●	●	●	—	●	C, M S, T
R.G.D.	(50)	●	—	—	—	●	●	●	●	—
Radiomobile	(70)	—	—	—	—	—	—	—	—	M
Regentone	(66)	●	—	—	—	●	●	—	●	—
Romac	(88)	—	—	—	●	—	●	—	—	M
Sobell	(63)	●	—	—	●	●	●	—	●	—
Trix	(25)	—	—	—	—	—	—	—	—	S
Ultra	(59)	●	—	●	●	●	●	—	●	—
Vidor	(47)	●	●	●	●	—	●	●	—	—
W.B.	(62)	●	—	—	—	—	●	—	—	K

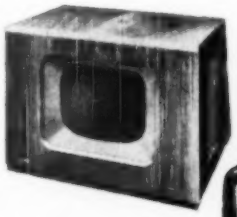
C, communications; F, f.m.; K, kit; M, car; S, schools; T, trawler-band; Y, yacht.



Adjustable tuning over the whole television band is provided in this Bush Model TV22 re-receiver, which incorporates a 9in tube.



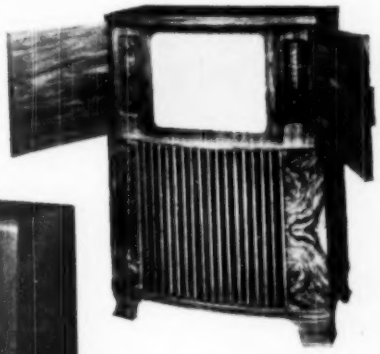
Baird portable television receiver, Model T165, which utilizes the mains lead as an aerial.



Pye "dark screen" television receiver, Model LV30, incorporating a 9in tube.

Flat-ended tube with aluminized screen and permanent-magnet focusing are features of the G.E.C. Model BT2147 receiver.

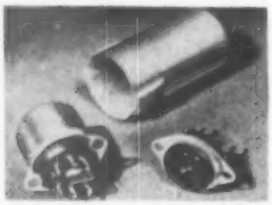
(Below) Vidor television receiver fitted with 12in tube. All controls are at the front.



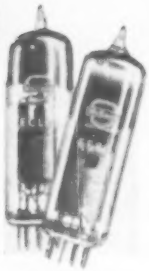
(Above) Philips projection television receiver, Model 600A, giving a picture 13½ × 10½in.

(Right) Marconiphone, Model VT75A, table television receiver.

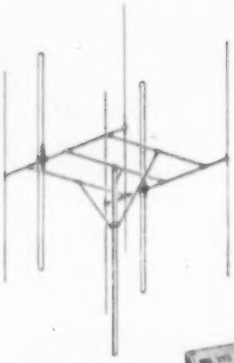
Decca projection television receiver incorporates a broadcast chassis covering eight wavebands.



Belling-Lee B7G valve holders and screen.



Mullard "Noval-based" 9-pin television valves.



Wolsey six-element broadside-array with two folded dipoles.

Amplion Model DB1 a.c. power unit for all-dry battery portables.

TRANSMITTERS: Including Low-power Transmitter Receivers

FIRM	(Stand)	Broadcasting	Point-to-point	Airborne	Marine	Mobile V.H.F.	Keying and Control
A.T.M.	(41)	—	●	—	●	●	●
G.E.C.	(58, 77)	—	●	—	●	●	—
Pye	(8, 49)	—	●	—	●	●	—
Romac	(88)	—	—	●	—	●	—
S.T.C.	(43)	●	—	—	—	●	—
Wolsey	(107)	—	—	—	—	●	—

TEST AND MEASURING GEAR: Including Signal Generators and Test Sets

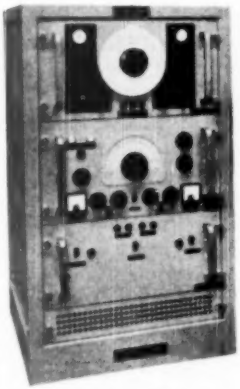
FIRM	(Stand)	Single-range pointer meters	Multi-range meters	Bridges and accessories	Valve voltmeters	Test sets	Signal sources	Television signal sources	Oscilloscopes	Servicing tools and materials
A.T.M.	(41)	—	—	●	—	●	●	—	—	—
Amplion	(82)	—	●	—	—	—	—	—	—	—
Avo	(26)	—	●	●	●	●	●	●	—	—
Bulgin	(3)	—	—	—	—	—	—	—	—	●
Cossor	(7, 52)	—	—	—	—	—	—	●	●	—
Eddystone	(83)	—	—	—	—	●	—	—	—	●
Ediswan	(33)	—	—	—	—	—	●	—	—	—
English Electric	(35)	—	—	—	●	●	—	●	●	—
Kerry's	(95)	—	●	—	—	—	—	—	—	—
Mullard	(64, 74)	—	—	—	—	●	—	—	—	—
Pye	(8, 49)	—	—	—	—	●	●	●	—	—
Taylor	(2)	●	●	●	●	●	●	●	●	—

COMPONENTS: Excluding Accessories and Sub-Assemblies

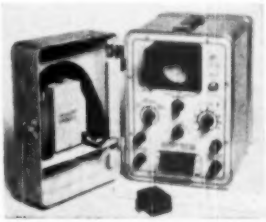
FIRM	(Stand)	Capacitors: Fixed	Capacitors: Variable	Capacitors: Trimmers	Resistors: Non-ohmic	Resistors: Fixed wire-wound	Resistors: Variable	Switches	Coils, R.F.	Transformers, mains	Transformers, audio (inc. output)	Chokes	Plugs, sockets, connectors, adaptors	Chassis fittings (valveholders, etc.)	Cabinets, racks, chassis	Dials, drives, knobs	Relays	Vibrators	Television scan. components
A.T.M.	(41)	●	—	—	—	—	—	—	—	—	●	—	—	—	—	—	●	—	—
Aeralite	(76)	—	—	—	—	—	—	—	—	—	—	—	●	—	—	—	—	—	—
Amplion	(82)	—	—	—	—	—	●	—	—	—	—	—	●	—	—	—	—	—	—
Antiference	(18)	—	—	—	—	—	—	—	—	—	—	—	●	—	—	—	—	—	—
Belling-Lee	(71)	—	—	—	—	—	—	—	—	—	—	—	●	●	—	—	—	—	—
B.I. Callender's	(80)	●	—	—	—	—	—	—	—	—	—	—	●	●	—	—	—	—	—
Bulgin	(3)	●	—	●	—	●	●	●	●	—	●	●	●	●	—	●	—	●	—
Bush	(48, 105)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	●	—
Coulphone	(97)	—	—	—	—	—	—	—	—	●	●	●	—	—	—	—	—	—	—
Dynatron	(69)	—	—	—	—	—	—	—	—	—	—	—	—	—	●	—	—	—	—
Eddystone	(83)	—	●	—	—	—	—	—	●	—	—	●	●	●	●	●	—	—	—
Ediswan	(33)	●	—	—	—	—	—	—	—	—	—	—	—	●	—	—	—	—	—
G.K.N.	(29)	—	—	—	—	—	—	—	—	—	—	—	—	●	—	—	—	—	—
J.B. Manufacturing	(98)	—	—	—	—	—	—	—	—	—	—	—	—	—	●	—	—	—	—
Mullard	(64, 74)	—	—	—	●	—	—	—	—	—	—	—	—	—	—	—	—	—	●
Pye	(8, 49)	—	—	—	—	—	—	—	—	—	—	—	●	—	—	—	●	—	—
S.T.C.	(43)	●	—	—	●	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Telcon	(79)	—	—	—	—	—	—	—	—	—	—	—	●	—	—	—	—	—	—
W.B.	(62)	—	—	—	—	—	—	—	—	●	●	●	—	●	●	—	—	—	—
Winter Trading	(96)	—	—	—	—	—	—	—	●	●	●	●	—	—	●	—	—	—	●
Wolsey	(102)	—	—	—	—	—	—	—	—	—	—	—	●	—	—	—	—	—	—

ACCESSORIES: Including Materials, Valves and Non-electronic Rectifiers

FIRM	(Stand)	Aerials: Broadcast	Aerials: Television and E.H.F.	Aerials: Anti-interference	Aerials: Car	Valves	C.R. tubes	Photocells	Metal rectifiers	Crystal valves	Time switches	Batteries	Power units (inc. rotaries)	Interference suppressors	Magnets	Magnetic materials (inc. dust cores)	Wire and cable	R.F. cable	Insulants	Solder	Television pre-amplifiers	Television E.H.T. units	Television lenses
A.T.M.	(41)	—	—	—	—	●	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Acrylite	(14)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	●
Aerialite	(76)	●	●	●	●	—	—	—	—	—	—	—	—	●	—	—	●	●	—	—	—	—	—
Amplion	(82)	—	—	—	—	—	—	—	—	—	—	—	●	—	—	—	—	—	—	—	—	—	—
Antiference	(18)	●	●	●	—	—	—	—	—	—	—	—	—	●	—	—	—	—	—	—	—	—	—
B.C.L.	(9)	—	—	—	—	—	—	—	—	—	—	●	—	—	—	—	—	—	—	—	—	—	—
Baird	(39)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	●	—	●
Belling-Lee	(71)	●	●	●	●	—	—	—	—	—	—	—	—	●	—	—	—	—	—	—	—	—	—
B.I. Callender's	(80)	—	—	●	—	—	—	—	—	—	—	—	—	—	—	—	●	●	—	—	—	—	—
Concord	(5)	●	—	—	—	—	—	—	—	—	—	—	—	—	—	—	●	—	—	—	—	—	—
Cossor	(7, 52)	—	—	—	—	●	●	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Decca	(22, 37, 40)	—	—	—	—	—	—	—	—	—	—	—	●	—	—	—	—	—	—	—	—	—	—
Eddystone	(83)	●	●	—	—	—	—	—	—	—	—	—	●	—	—	—	—	—	—	—	—	—	—
Ediswan	(33)	—	—	—	—	●	●	—	—	—	—	●	—	—	—	—	—	●	—	—	—	—	—
Electro Dynamic	(9)	—	—	—	—	—	—	—	—	—	—	—	●	—	—	—	—	—	—	—	—	—	—
Ferranti	(55)	—	—	—	—	—	●	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Fine Wires	(101)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	●	—	—	—	—	—	—
G.E.C.	(58, 77)	—	—	—	—	●	●	●	—	●	—	●	—	—	—	—	—	—	—	—	—	—	—
H.M.V.	(12, 65)	—	●	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	●	—	—
K.A.	(99)	—	●	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Kerry's	(95)	—	—	—	—	—	—	—	—	—	—	—	●	—	—	—	—	—	—	—	—	—	—
Magnavista	(78)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	●
Marconiphone	(51)	—	●	—	—	●	●	—	—	—	—	●	—	—	—	—	—	—	—	—	—	—	—
Masteradio	(28)	—	—	—	●	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Mullard	(64, 74)	—	—	—	—	●	●	●	—	—	—	—	—	—	●	●	—	—	—	—	—	●	—
Multicore	(86)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	●	—	—	—
Radiomobile	(70)	—	—	—	●	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Rornac	(88)	—	—	—	—	—	—	—	—	—	—	—	●	—	—	—	—	—	—	—	—	—	—
S.T.C.	(43)	—	—	—	—	●	●	—	●	—	●	—	—	—	—	—	—	—	—	—	—	—	—
Scott	(104)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	●	—	—	—	—	—	—	—
Telcon	(79)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	●	●	●	●	—	—	—	—
Telerection	(100)	—	●	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Vidor	(47)	—	—	—	—	—	—	—	—	—	—	●	●	—	—	—	—	—	—	—	—	—	—
W.B.	(62)	—	—	—	—	—	—	—	—	—	—	—	—	—	●	—	—	—	—	—	●	—	—
Westinghouse	(16)	—	—	—	—	—	—	—	●	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Winter Trading	(96)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	●	●
Wolsey	(102)	—	●	—	—	—	—	—	—	—	—	—	—	—	—	—	—	●	—	—	—	—	—

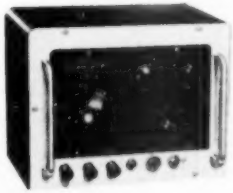


S.T.C. frequency-shift keying equipment for short-wave transmitters.



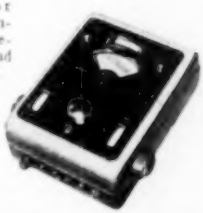
Telegraph distortion measuring set made by A.T.M.

Marconi Instruments (English Electric) television sweep generator, Model TF923, is shown below. It can be used for checking receivers, aerials and feeders.



(Right) Cossor, Model 1320, television alignment and pattern generator.

(Right) Avo universal bridge for measuring inductance, resistance and capacitance.



SOUND REPRODUCING EQUIPMENT

Audio-Amplifiers and Electro-Acoustic Apparatus

FIRM (Stand)	Microphones	Pickups	Amplifiers	Loudspeakers	Gramophone motors	Record changers	Electric gramophones	Record players	Recorders, magnetic	Hearing aids
Amplion (82)	—	●	—	●	—	—	—	●	—	—
Baird (19)	—	—	—	—	—	—	—	—	T	—
Co-op (61)	—	—	—	●	—	—	—	●	—	—
Coulphone (97)	—	—	●	—	—	—	—	—	—	—
Decca (22, 37, 40)	—	●	●	●	●	●	●	●	—	—
Dynatron (69)	—	—	●	—	—	—	—	—	—	—
Eddystone (83)	—	—	—	●	—	—	—	—	—	—
Ediswan (33)	—	●	—	●	—	—	—	—	—	—
G.E.C. (58, 77)	●	—	●	●	—	—	—	—	T	—
Garrard (32)	—	●	—	—	●	●	—	—	—	—
Goodmans (85)	—	—	—	●	—	—	—	—	—	—
H.M.V. (12, 65)	—	—	—	—	—	●	●	●	—	—
K.B. (36)	—	—	—	—	—	—	—	●	W	●
Marconiphone (51)	—	●	—	—	—	●	—	●	—	—
Peto Scott (84)	—	—	●	—	—	—	—	●	—	—
Portogram (94)	—	—	●	—	—	—	●	●	—	—
Pye (8, 49)	—	—	●	—	—	—	—	—	—	—
R.G.D. (50)	●	—	●	●	—	—	—	●	T	—
Trix (25)	●	—	●	●	—	—	●	●	—	—
Vidor (47)	—	—	—	—	—	—	—	●	—	—
W.B. (62)	—	—	●	●	—	—	●	—	—	—
Westerman (87)	—	—	—	—	—	—	—	—	—	●

T, tape; W, wire.

Goodmans omni-directional public-address loudspeaker, known as the Concentric Diffuser.

Garrard three-speed automatic record changer, Model RC72.

(Below) Stentorian 12in Concentric Duplex loudspeaker (W.B.).

Model P158 three-speed "Trixette" electric gramophone (Trix).

NUMERICAL LIST OF STANDHOLDERS WITH NAMES AND ADDRESSES

1 **Taylor Electrical Instruments**, 419, Montrose Ave., Slough, Bucks.
2 **A. F. Bulgin & Co.**, Rye Place Rd., Barking, Essex.
3 **Cosmocelia Electric Wire & Cable Co.**, Long Eaton, Nr. Nottingham.
6 **Barclays Bank**, 54 Lombard St., London, E.C.3.
7 **A. C. Cossor**, Highbury Grove, London, N.5.
8 **Pye**, Radio Works, Cambridge.
9 **Electro Dynamic Construction Co.**, 46, Mary Cres., Kent.
Battery Construction, Bristol Rd., Bridgwater, Som.
10 **"Wireless World" & "Wireless Engineer,"** Dorset House, Stamford St., London, S.E.1.
11 **H. K. Cole**, Elm Works, Southend-on-Sea, Essex.
12 **Gramophone Co.**, Hayes, Middx.
13 **Rediffusion Co.**, 1, Victoria St., London, S.W.1.
14 **Motor & Air Products**, 24, Bridge St., Leather-head, Surrey.
15 **"Electronic Engineering,"** 29, Essex St., London, W.C.2.
16 **Westinghouse Brake & Signal Co.**, 82, York Way, King's Cross, London, N.1.
17 **"Television Weekly,"** 29 - 00, Broughton Rd., London, S.W.6.
18 **Amplivox**, 67, Bryanston St., London, W.1.
19 **Air Ministry**, Parliament St. House, Parliament St., London, S.W.1.
20 **"Practical Wireless,"** Tower House, Southampton St., London, W.C.2.
21 **General Post Office**, London, E.C.1.
22 **Decca Record Co.**, 1-3, Brixton Rd., London, S.W.9.
23 **Hobbies Bros.**, 31-37, 43, Eastern St., London, E.C.2.
24 **Midland Auto Components**, 58, Cambridge St., Birmingham.
25 **Trix Electrical Co.**, 1-3, Maple Place, Tottenham Court Rd., London, W.1.
26 **Automatic Coil Winder & Electrical Equipment Co.**, Winder House, Douglas St., London, S.W.1.
27 **"Birmingham Gazette,"** Gazette Buildings, Corporation St., Birmingham, 2, Warwicks.
28 **Masteradio**, 19-20, Poland Place, London, S.W.1.
29 **Dossi, Keen & Nettlefolds**, Box No. 34, Heath St., Birmingham, 18, Warwicks.
30 **Lloyds Bank**, 71, Lombard St., London, E.C.3.
31 **Association of Radio Battery Manufacturers**, 41, Gordon Square, London, W.1.
32 **Garrard Engineering & Manufacturing Co.**, New-castle St., Swindon, Wilts.
33 **Edison Swan Electric Co.**, 155, Charing Cross Rd., London, W.C.2.
34 **General Post Office**, London, E.C.1.
35 **English Electric Co.**, Queen House, Kingsway, London, W.C.2.
36 **Kolster-Brandes**, Footscray, Sidcup, Kent.
37 **Decca Record Co.**, 1-3, Brixton Rd., London, S.W.9.
38 **Philips Overseas**, 254/256, 60, Portland St., London, W.1.
39 **Stephens Baird**, Lancelot Rd., Wembley, Middx.
40 **Decca Record Co.**, 1-3, Brixton Rd., London, S.W.9.
41 **Automatic Telephone & Electric Co.**, Strowger House, Arundel St., London, W.C.2.
42 **Philips Electrical**, Century House, Shaftesbury Ave., London, W.C.2.
43 **Standard Telephones & Cables**, Connaught House, Aldwych, London, W.C.2.
44 **Murphy Radio**, Welwyn Garden City, Herts.
45 **Philips Electrical**, Century House, Shaftesbury Ave., London, W.C.2.
46 **Invicta Radio**, Parkhouse Rd., Holway, London.
47 **Vidor**, West St., Erith, Kent.
48 **Bush Radio**, Power Rd., London, W.4.
49 **Pye**, Radio Works, Cambridge.
50 **Radio Gramophone Development Co.**, Pye Meadow Works, Bellegrove Rd., Sidcup.
51 **Marconiphone Co.**, Hayes, Middx.
52 **A. C. Cossor**, Highbury Grove, London, N.5.
53 **E. K. Cole**, Elm Works, Southend-on-Sea, Essex.
54 **A. J. Balcombe**, 52, Tottenham St., London, E.C.2.
55 **Ferranti**, Hollinwood, Lancs.
56 **Pilot Radio**, 52, Park Royal Rd., London, N.W.10.
57 **McMichael Radio**, Oxt. Street, London, W.C.2.
58 **General Electric Co.**, Magnet House, Kingsway, London, W.C.2.
59 **Ultra Electric**, Western Ave., Acton, London, W.3.
60 **Hale Electric Co.**, Radio Works, Talbot Rd., West Ealing, London, W.13.
61 **Co-operative Wholesale Society**, 1, Balloon St., Manchester, 4, Lancs.
62 **Whiteley Electrical Radio Co.**, Victoria St., Mansfield, Notts.
63 **Scholl Industries**, Langley Pk., Nr. Slough, Bucks.
64 **Mullard Electronic Products**, Century House, Shaftesbury Ave., London, W.C.2.
65 **Gramophone Co.**, Hayes, Middx.
66 **Rediffusion Products**, Eastern Ave., Romford, Essex.
67 **Ferguson Radio Corpn.**, 195, Aldwych, London, W.C.2.
68 **R. S. Fitter**, Pylmore Works, Brighton, Sussex.
69 **Dynatron Radio**, Purbeck Works, Rye Lane Rd., Maidenhead, Berks.
70 **Radiomobile**, Chickenwood Works, London, N.W.2.
71 **Belling & Lee**, Cambridge Arterial Rd., Enfield, Middx.
72 **Brown Brothers**, 101, Eastern St., London, E.C.2.
73 **Champion Electric Corpn.**, Champion Works, Seaford, Sussex.
74 **Mullard Electronic Products**, Century House, Shaftesbury Ave., London, W.C.2.
75 **Westminster Bank**, 41, Threadneedle St., London, E.C.2.
76 **Aerialite**, Castle Works, Stalybridge, Cheshire.
77 **General Electric Co.**, Magnet House, Kingsway, London, W.C.2.
78 **Metro Pye**, 28, Gt. Portland St., London, W.1.
79 **Telegraph Construction & Maintenance Co.**, 22, Old Broad St., London, E.C.2.
80 **British Insulated Callender's Cables**, Norfolk House, Norfolk St., London, W.C.2.
82 **Amplion**, 230, Tottenham Court Rd., London, W.1.
83 **Stratton & Co.**, Eddystone Works, Alvechurch Rd., West Heath, Birmingham, 31, Warwicks.
84 **Peto Scott Electrical Instruments**, Addlestone Rd., Weybridge, Surrey.
85 **Goodmans Industries**, Lancelot Rd., Wembley, Middx.
86 **Multicore Solders**, Mellier House, Albemarle St., London, W.1.
87 **F. Westerman** (Wholesale), 84, Dale End, Birmingham, 4, Warwicks.
88 **Romar Radio Corpn.**, The Hyde, Hendon, London, N.W.9.
89 **"Daily Mail,"** Northcliffe House, E.C.4.
90 **E. A. Wood**, 100, Aston Rd., Birmingham, 6, Warwicks.
91 **Midland Bank**, Poultry, London, E.C.2.
92 **E. K. Cole**, Elm Works, Southend-on-Sea, Essex.
93 **"Wireless & Electrical Trader,"** Dorset House, Stamford St., London, S.E.1.
94 **Portogram Radio Electrical Industries**, Friel Works, St. Rule St., London, S.W.8.
95 **Kerry's (G.E.)**, Warton Rd., Stratford, London, E.15.
96 **Winter Trading Co.**, 8 Harrow Rd., Paddington, London, W.2.
97 **Coulphone Radio**, 37, Burscough St., Ormskirk, Lancs.
98 **J. B. Manufacturing Cabinet Co.**, 90, Palmerston Rd., Walthamstow, London, E.17.
99 **B. Kimber, Allen & Co.**, Metro Works, Mitch Place, Lewisham, London, S.E.13.
100 **Telerection**, 15, Suffolk Parade, Cheltenham, Glos.
101 **Fine Wires**, Green Rd., Castle Boulevard, Nottingham.
102 **Wolsey Television**, 72, Goodman Rd., Brixton, London, S.W.9.
103 **Domain Industries**, Domain Works, Barnby St., London, S.W.1.
104 **Geo. L. Scott & Co.**, Cromwell Rd., Ellesmere Port, Cheshire.
105 **Bush Radio**, Power Rd., London, W.4.
106 **"Electrical & Radio Trading,"** 36, Long Acre, London, W.C.2.
107 **British Railways**, 222, Marylebone Rd., London, N.W.1.
108 **National Provincial Bank**, 15, Bishopsgate, London, E.C.2.

Flyback E.H.T.

(Concluded from page 282, August Issue)

2—Characteristics of the Circuit

By W. T. COCKING, M.I.E.E.

THE general argument leads to the conclusion that the requirement for good regulation is a high ratio of energy in the deflector-coil circuit to the energy drawn from the e.h.t. system by the tube. It tells us nothing about how big the ratio must be for a given regulation, however, nor does it indicate how the magnitude of the damping affects matters. The detailed analysis of the Appendix is necessary for this and its results are presented in Figs. 5, 6 and 7. The damping is here indicated by the Q of the circuit ($Q = R\sqrt{C/L}$). It is interesting to notice that the Q has very little effect on the regulation. For values of $LI^2/V_{HT}i_{HT}$ over 4.5×10^{-3} the effect of varying Q is indistinguishable on the curves. For smaller values, Q does have a noticeable effect, but it is still very small.

This at first seems surprising for the power dissipated in R increases as Q is lowered and one would expect the ratio of circuit volt-amperes to e.h.t. power to increase to make up for this loss. This would occur if the curves were plotted in terms of $Li_a^2/V_{HT}i_{HT}$ instead of $LI^2/V_{HT}i_{HT}$ for the value of I/i_a depends very much upon the Q.

The peak-to-peak current I is regarded here as more fundamental than the peak current i_a; I must be provided for deflection, i_a depends on I and Q, and Q depends on what is practicably obtainable and upon what is usable in a given type of circuit. The relation between I and i_a is dependent on scanning requirements only and is either settled by the Q available or Q is chosen to provide the required relation. Of course, I/i_a is affected somewhat by the load of the e.h.t. supply, but this is taken into account in Fig. 5.

The measure of volt-amperes in the deflecting circuit is made LI^2 because this is also a convenient measure of deflector-coil characteristics. It is not actually a volt-ampere product; to be this it would have to be divided by the repetition period of the saw-tooth. Time does come into the expression used in computing Fig. 5, but it has been included as a numerical figure of 98.77 μsec.

A typical deflector coil has an LI^2 figure of 1.5 mH-A^2 with a tube operating at 5 kV. A transformer may have a field efficiency of 70 per cent. The effective LI^2 figure at the primary then becomes $1.5/0.7 = 1.86$ mH-A^2. With a current of 120μA at 5 kV, $V_{HT}i_{HT}$ is $5 \times 0.12 = 0.6$ watt and so $LI^2/V_{HT}i_{HT} = 1.86 \times 10^{-3}/0.6 = 3.1 \times 10^{-3}$. Reference to Fig. 5 shows $V_{HT}/V_m = 0.88$, about. The zero to full-load regulation is thus $100(1 - 0.88) = 12\%$. With $V_{HT} = 5$ kV, V_m becomes $5/0.88 = 5.68$ kV and the change of voltage is 680 V; therefore, the internal resistance of the supply is $680/120 = 5.7$ MΩ.

If better regulation is needed, then it is necessary to increase LI^2. This means, of course, that a less efficient deflector coil or transformer must be used. The pursuit of efficiency in these components may, therefore, be a waste of time when e.h.t. is taken from the fly-back!

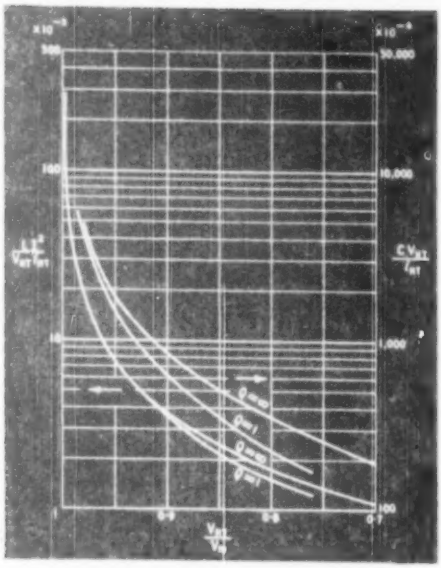


Fig. 5. Variation of $LI^2/V_{HT}i_{HT}$ and CV_{HT}/i_{HT} with V_{HT}/V_m for Q values of 1 and ∞.

In the case quoted the LI^2 figure was taken as a reasonable one for good components and it led to a usable figure for the regulation. Suppose now that the tube voltage is doubled so that V_{HT} becomes 10 kV, the current remaining unchanged. LI^2 is also doubled, because the current needed for deflection increases as $\sqrt{V_{HT}}$, so that $LI^2/V_{HT}i_{HT}$ is unchanged and the regulation is unaffected. This is very important because it means that the regulation is independent of the voltage.

The LC product needed in the circuit is also independent of voltage (Equ. 24 in the Appendix) but depends on the fly-back time, the Q and the regulation. For a given Q, if LC is chosen to give the required fly-back time at full current, then at lower current the fly-back will be a little quicker. The change is not large because the conduction time of the diode is only a small fraction of the total fly-back time and it is the conduction time which is directly affected by the current.

For a given maximum current, the voltage obtainable is inversely proportional to the circuit capacitance. As capacitance cannot be reduced indefinitely this sets a limit to the maximum voltage obtainable.

For the case of $LI^2 = 3.1 \times 10^{-4}$ and $V_{HT} = 5$ kV, we see from Fig. 5 that for a low Q circuit $CV_{HT}/i_{HT} = 480 \times 10^{-8}$ and for a high Q it is 670×10^{-8}. With $i_{HT} = 120$ μA, we have 5.86×10^{-8} and 8.2×10^{-8} respectively for CV_{HT} and so C becomes 11.9 pF and 16.4 pF. A high-Q circuit has an advantage in permitting a higher circuit capacitance. In both cases the circuit capacitances are low and may be impracticably low. Certainly, appreciably smaller values, and hence much higher e.h.t. voltages, would be impossible.

If the circuit Q is large so that the losses in R are negligibly small the equations in the Appendix can be greatly simplified for then $\omega t_1 = \sin^{-1} V_{HT}/V_m$ and $I/i_0 = 1 + V_{HT}/V_m$. Then

$$\frac{LI^2}{V_{HT}i_{HT}} = 2\pi \frac{1 + V_{HT}/V_m}{1 - V_{HT}/V_m}$$

$$\frac{CV_{HT}}{i_{HT}} = 2\pi \frac{(V_{HT}/V_m)^2}{1 - (V_{HT}/V_m)^2}$$

Eliminating i_{HT} between the two equations we get

$$C = \frac{LI^2}{V_{HT}^2} \cdot \left(\frac{V_{HT}/V_m}{1 + V_{HT}/V_m}\right)^2$$

which shows that for a given regulation and deflector-coil energy the capacitance required is inversely proportional to the square of the voltage. If LI^2 is fixed at the requirements for scanning there is a decided limit to the e.h.t. voltage obtainable because there is a physical limit to the extent to which C can be reduced. However, this limit of voltage is only for a given type of rectifier. If a voltage doubler rectifier is substituted for a half-wave, then in the ideal case the rectifier output voltage V_V and input current i_{HT} are doubled. Since i_{HT} does not appear in the above equation and V_{HT} still refers to the circuit voltage, the permissible capacitance is increased four times or, for the same capacitance the tube voltage is doubled. Voltage-multiplying rectifiers are thus essential for high tube voltages.

The regulation is unaffected by the use of such a rectifier for although the input voltage and current are changed their product is constant. This is, of course, in the ideal case. In practice, the regulation of a voltage-multiplying rectifier is itself poorer than that of a half-wave because there is a greater power loss within it. Where it is practicable to use a half-wave rectifier, therefore, this kind should be used.

We have seen that the regulation is hardly affected by the Q of the circuit. This does not mean, however, that the effect of the regulation on the width of the picture is unaffected by Q. The deflection D is inversely proportional to the square root of the tube anode voltage and directly proportional to the deflecting current I; that is,

$$D \propto 1/\sqrt{V_T} \propto 1/\sqrt{V_{HT}} \text{ and } D \propto I$$

Now $I = i_0\left(1 + \frac{V_{HT}}{V_m} e^{-\pi\beta/\omega}\right)$ where i_0 is the peak current in the circuit at the start of fly-back and is constant because it is supplied by the driving valve. We get, therefore,

$$D = k\left[\sqrt{\frac{V_{HT}}{V_m}}\, e^{-\pi\beta/\omega} + \sqrt{\frac{V_m}{V_{HT}}}\right]$$

where k is a constant, and $\beta/\omega = 1/2Q\sqrt{1 - 1/4Q^2}$. Writing for simplicity x_1 for any given value of V_{HT}/V_m, Δx for a small change from this value, D_1 for the picture width at x_1 and ΔD for the change of picture width corresponding to Δx we get

$$\frac{\Delta D}{D_1} \approx -\frac{1}{2} \cdot \frac{\Delta x}{x_1} \cdot \frac{1 - x_1 e^{-\pi\beta/\omega}}{1 + x_1 e^{-\pi\beta/\omega}} + \frac{1}{8}\left(\frac{\Delta x}{x_1}\right)^2 \frac{3 - x_1 e^{-\pi\beta/\omega}}{1 + x_1 e^{-\pi\beta/\omega}}$$

For a given $\Delta x/x_1$ it is clear that $\Delta D/D_1$ becomes smaller as $x_1 e^{-\pi\beta/\omega}$ approaches unity; if $Q = \infty$, $e^{-\pi\beta/\omega} = 1$ and $\Delta D/D_1$ is at its minimum. Therefore, in order to minimize the effect of the regulation on picture width the circuit Q should be as large as possible. As an example, consider two limiting cases with $x_1 = 0.9$ and $\Delta x = \pm 0.1$. If $Q = \infty$ the above expression gives $\Delta D/D_1 = -0.0012$ and 0.0046 whereas if $Q = 1$ we find $\Delta D/D_1 = -0.037$ and 0.046. The high Q circuit is thus at least ten times as good as the low Q.

It seems, therefore, that the use of a high-Q circuit offers a very considerable advantage. In fact, any reasonably good regulation of the e.h.t. supply is sufficient for the effect on picture width to be negligible.

Unfortunately, this is only part of the story. The frame scanning current is constant so that picture height will be proportional to $1/\sqrt{V_{HT}}$. The picture height will, therefore, change more than the picture width and the aspect ratio will be affected by the regulation of the e.h.t. supply. With a low-Q circuit this effect will not be appreciable.

Also, variations of V_{HT} affect the focus and the compensating action of a high-Q circuit does nothing to reduce this. The best results are thus clearly obtained by using a low-Q circuit and making the regulation adequate by keeping LI^2 large. This is an uneconomical condition, however, in that it leads to a line-scanning stage which demands a large power input from the h.t. supply.

From the technical point of view, the right answer to all these problems is to keep the load on the e.h.t. system constant, so that V_{HT}/V_m and I remain constant. The tube current necessarily changes, so that the maintenance of a constant load on the e.h.t. circuit demands the connection to the output of a shunt circuit having special characteristics. It must absorb little or no current when the tube is drawing full current, and the full tube current when the tube ceases to take current.

The obvious thing to use is a shunt valve stabilizer, but this is ruled out by the absence of a suitable valve. A high-g_m triode or pentode is required which is capable of withstanding the full e.h.t. voltage on its anode.

It is, however, possible to approach the regulated

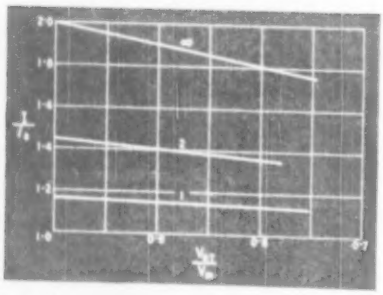


Fig. 5. Variation of I/i_0 with V_{HT}/V_m for Q values of 1, 2 and ∞.

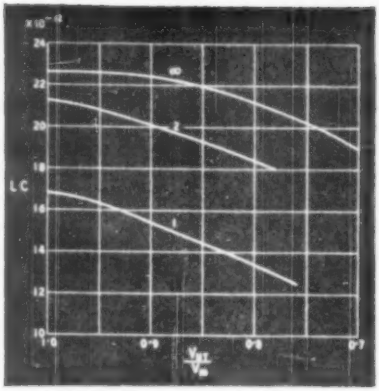
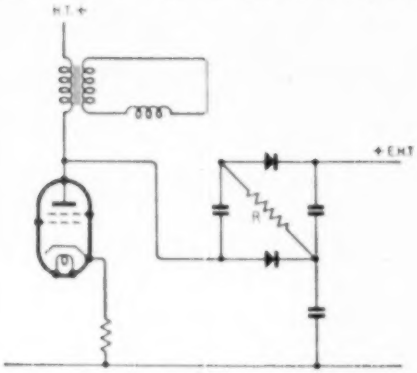


Fig. 7. Variation of LC with V_{RT}/V_m for Q values of 1, 2 and ∞.

Fig. 8. Typical voltage-doubling e.h.t. rectifier system.



condition by shunting the output by a suitable semi-conductor. Such materials have a resistance which, above a certain applied voltage, decreases rapidly with an increase of voltage. The back resistance of selenium rectifiers is an example and a considerable improvement in regulation is possible if a suitable rectifier is connected across the e.h.t. supply.

Since the back resistance of the e.h.t. rectifier is in shunt with the supply during the "non-conductive" period, this rectifier can provide the stabilizing action as well as the rectifying. By careful choice of the operating conditions, therefore, it should be possible to obtain better regulation with metal rectifiers than with thermionic rectifiers.

Since these rectifiers need no filament supply they are especially convenient in voltage-multiplying circuits. These circuits have a bad reputation for regulation, but this has been acquired in mains-supply service where the source is of low impedance and the rectifier itself is the major cause of poor regulation. In fly-back systems it is the source which is mainly responsible for the regulation with the result that the greater power loss in a voltage-doubler has relatively little effect.

Most of the regulation effects of the voltage-doubler are due to the series resistance R of Fig. 8 and this is usually around 1·2 MΩ. It can be taken into account by adding it to the effective internal impedance of the source, viewed from the output.

Thus, suppose $V_{RT} = 3$kV, $i_T = 200\ \mu$A and $V_{RT}/V_m = 0.9$ at full current. Then $\Delta V_{RT} = 300$V and the source impedance is $300/200 = 1.5$ MΩ. The equivalent impedance viewed from the output is four times this, or 6 MΩ, because the voltage is doubled and the current halved in the voltage-doubling rectifier system. This is also the impedance of a half-wave system supplying 6 kV at 100 μA.

Taking the feed resistor of 1 MΩ into account the impedance becomes 7 MΩ. For a change of current of 100 μA in the output (200 μA at the input of the voltage-doubler), the change of voltage is 700 V instead of 600 V and so the regulation is $100 \times 700/6{,}000 = 11.6\%$ instead of 10%. In fact, it is slightly worse than this for there are two rectifiers in series instead of one only. It can, however, be made still better by replacing the resistance by a third rectifier, since this will have a lower forward resistance. The gain is not usually sufficient to justify this, however.

In conclusion, the main properties of fly-back e.h.t. systems can be summarized as follows :—

(1) With a given deflector coil, transformer and rectifier system the regulation is independent of the tube operating voltage because $I \propto \sqrt{V_{RT}}$ and $LI^2/V_{RT}i_{RT}$ is, therefore, constant. This assumes that the changes of tube current are independent of the tube anode voltage.

(2) The regulation is nearly independent of the Q value of the circuit comprising the deflector coil and transformer.

(3) With a given deflector coil, transformer and rectifier system the maximum tube voltage is limited by circuit capacitance. The circuit Q also has an appreciable effect and a very high-Q circuit enables about 40% more voltage to be obtained than with a very low-Q circuit for the same capacitance.

(4) The capacitance limit to the voltage can be overcome by using a voltage-multiplying rectifier system. The circuit regulation is unaffected by this if the power loss in the rectifier system is negligible.

(5) With a very low-Q circuit the regulation affects picture width and height nearly equally and the aspect ratio is hardly affected. With a high-Q circuit the regulation affects I and this largely compensates for the effect on picture width. Picture height is directly affected by the regulation and so with a high-Q circuit the regulation affects the aspect ratio.

(6) In all cases the regulation affects the focus.

(7) Because of the high source impedance the regulation with a voltage-doubling rectifier is only slightly poorer than with a half-wave.

For the benefit of those who like to know how results are derived a full analysis of the circuit is given in the Appendix. It leads to the results which, for the British 405-line system, are summarized in Figs. 5, 6 and 7.

APPENDIX

Referring to Fig. 1 let the initial circuit in L be i_0. The instantaneous current i_L resulting from its decay is the same as that which would be obtained if i_0 were maintained indefinitely and a unit impulse of current $i_0 1$ were applied to the circuit so that the current in L resulting from it is in opposition to i_0. Then

$$v = i_0 Z 1 \qquad (1)$$

$$i_L = i_0 - i_0 (Z/pL) 1 \qquad (2)$$

where $p = d/dt$

$$Z = \frac{1}{pC + \frac{1}{R} + \frac{1}{pL}} = R\,\frac{2\alpha p}{p^2 + 2\alpha p + \omega_0^2}$$

$$\alpha = 1/2RC; \quad \omega_0^2 = 1/LC$$

Whence

$$v = i_0 R\,\frac{2\alpha p}{p^2 + 2\alpha p + \omega_0^2}\,1 \quad \ldots \quad (3)$$

$$i_L = i_0\,\frac{p^2 + 2\alpha p}{p^2 + 2\alpha p + \omega_0^2}\,1 \quad \ldots \quad (4)$$

Writing $\omega^2 = \omega_0^2 - \alpha^2$ these equations have the following solutions when $\omega_0 > \alpha$

$$v = i_0 R\,\frac{2\alpha}{\omega}\sin\omega t\,\epsilon^{-\alpha t} \quad \ldots \quad (5)$$

$$i_L = i_0\left[\cos\omega t + \frac{\alpha}{\omega}\sin\omega t\right]\epsilon^{-\alpha t} \quad \ldots \quad (6)$$

If V_2 is disconnected, the voltage v across the circuit reaches a maximum value V_m when $dv/dt = 0$. By differentiating Equ. (5) and equating to zero this is found to occur when $\omega t_m = \tan^{-1}(\omega/\alpha)$ and so*

$$V_m = i_0 R\,\frac{2\alpha}{\omega_0}\exp\left(-\frac{\alpha}{\omega}\tan^{-1}\frac{\omega}{\alpha}\right) \quad \ldots \quad (7)$$

When V_2 is connected the reservoir capacitance is charged to V_{HT} and so V_2 becomes conductive at some instant t_1 when $v = V_{HT}$ $(0 < t_1 < t_m)$; writing i_1 for the current at this instant we get

$$V_{HT} = i_0 R\,\frac{2\alpha}{\omega}\sin\omega t_1\,\epsilon^{-\alpha t_1} \quad \ldots \quad (8)$$

$$i_1 = i_0\left[\cos\omega t_1 + \frac{\alpha}{\omega}\sin\omega t_1\right]\epsilon^{-\alpha t_1} \quad \ldots \quad (9)$$

After t_1 Equs. (3) and (4) no longer apply because the ideal diode V_2 keeps the voltage constant at V_{HT}. Therefore, C no longer draws current and R draws a constant current V_{HT}/R. The current in L must fall linearly with time because V_{HT} is constant and becomes $i_1 - V_{HT}t/L$, time now being reckoned from t_1 as zero. The current i_v through the diode V_2 is the current in L less the current in R, therefore

$$i_v = i_1 - V_{HT}\frac{t}{L} - \frac{V_{HT}}{R} \quad \ldots \quad (10)$$

This current flows until $i_v = 0$ at $t = t_2$, therefore,

$$t_2 = \frac{L}{V_{HT}}\left(i_1 - \frac{V_{HT}}{R}\right) \quad \ldots \quad (11)$$

Since i_v varies linearly from $i_1 - V_{HT}/R$ at $t = 0$ to zero at $t = t_2$ its mean value is one-half of its initial value. The total charge conveyed through V_2 into C, during the conducting interval t_2 is thus

$$q = \frac{t_2}{2}\left(i_1 - \frac{V_{HT}}{R}\right) \quad \ldots \quad (12)$$

This charge must, in the equilibrium state, equal the charge withdrawn from C, by the constant current i_T of the c.r. tube during the whole interval τ between successive fly-backs. Therefore,

$$i_T\,\tau = \frac{t_2}{2}\left(i_1 - \frac{V_{HT}}{R}\right) = \frac{L}{2V_{HT}}\left(i_1 - \frac{V_{HT}}{R}\right)^2 \quad \ldots \quad (13)$$

After t_2 the diode becomes non-conductive again and the performance is that of an LCR circuit having for initial conditions a current V_{HT}/R in L and a voltage V_{HT} across C. Time is now to be reckoned from t_2 as zero. From Equ. (6) the current in L due to the initial current is

$$i_{L1} = \frac{V_{HT}}{R}\left[\cos\omega t + \frac{\alpha}{\omega}\sin\omega t\right]\epsilon^{-\alpha t} \quad \ldots \quad (14)$$

The current in L due to the charge on C is calculated with the aid of Fig. 2. By inspection

$$i_{L2} = \frac{V_{HT}}{\frac{1}{pC} + \frac{pLR}{pL + R}}\;\frac{pLR}{pL + R}\;\frac{1}{pL}\,1$$

$$= \frac{V_{HT}}{L}\;\frac{p}{p^2 + 2\alpha p + \omega_0^2}\,1$$

$$= \frac{V_{HT}}{\omega L}\sin\omega t\,\epsilon^{-\alpha t} \quad \ldots \quad (15)$$

The total current after t_2 is, therefore,

$$i_L = \frac{V_{HT}}{\omega L}\left[\frac{\omega L}{R}\cos\omega t - \left(1 - \alpha\frac{L}{R}\right)\sin\omega t\right]\epsilon^{-\alpha t} \quad \ldots \quad (16)$$

This has a maximum negative value, found by differentiating and equating to zero, at t_3, or

$$\omega t_3 = \tan^{-1}\left(-\frac{\omega}{\alpha}\right) = \pi - \tan^{-1}\frac{\omega}{\alpha} \quad \ldots \quad (17)$$

Therefore, the negative current maximum is

$$i_{Lm} = -\frac{V_{HT}}{\omega_0 L}\exp\left[-\frac{\alpha}{\omega}\left(\pi - \tan^{-1}\frac{\omega}{\alpha}\right)\right] \quad \ldots \quad (18)$$

and the peak to peak scanning current is

$$I = i_0 - i_{Lm} = i_0 + \frac{V_{HT}}{\omega_0 L}\exp\left[-\frac{\alpha}{\omega}\left(\pi - \tan^{-1}\frac{\omega}{\alpha}\right)\right] \quad (19)$$

The total fly-back time is

$$\tau_2 = t_1 + t_2 + t_3 \quad \ldots \quad (20)$$

The ratio of the voltage on full load to the voltage on open circuit is a design factor of major importance; it is given by the ratio of Equs. (8) and (7):

$$\frac{V_{HT}}{V_m} = \frac{\omega_0}{\omega}\sin\omega t_1\exp\left[-\frac{\alpha}{\omega}\left(\omega t_1 - \tan^{-1}\frac{\omega}{\alpha}\right)\right] \quad \ldots \quad (21)$$

Now $\omega_0 = 1/LC$ and we define Q as $R/\omega_0 L$; therefore, $Q = R\sqrt{C/L}$ and so

$$\frac{\alpha}{\omega_0} = \sqrt{\frac{LC}{2CR}} = \sqrt{\frac{L/C}{2R}} = \frac{1}{2Q}$$

$$\omega = \omega_0\sqrt{1 - \alpha^2/\omega_0^2} = \omega_0\sqrt{1 - 1/4Q^2}$$

$$\frac{\alpha}{\omega} = \frac{1}{2Q\sqrt{1 - 1/4Q^2}}$$

From Equs. (7) and (8)

$$\frac{V_{HT}}{V_m} = \frac{\exp\left(\frac{\alpha}{\omega}\tan^{-1}\frac{\omega}{\alpha}\right)}{\sqrt{1 - 1/4Q^2}}\sin\omega t_1\,\epsilon^{-\frac{\alpha}{\omega}\omega t_1} \quad \ldots \quad (22)$$

From Equs. (8), (9) and (11)

$$\omega t_2 = \sqrt{1 - 1/4Q^2}\left(\cot\omega t_1 - \frac{\alpha}{\omega}\right) \quad \ldots \quad (23)$$

$$\omega t_3 = \pi - \tan^{-1}\frac{\omega}{\alpha} \quad \ldots \quad (17)$$

From Equs. (17), (20) and (23)

$$LC = \frac{\tau_2^2\,(1 - 1/4Q^2)}{(\omega t_1 + \omega t_2 - \omega t_3)^2} \quad \ldots \quad (24)$$

From Equs. (8), (10) and (22)

$$\frac{I}{i_0} = 1 + \frac{V_{HT}}{V_m}\,\epsilon^{-\alpha t_2} \quad \ldots \quad (25)$$

From Equs. (8), (9) and (13)

$$\frac{LI^2}{V_{HT}\tau_2} = 2\tau\left[\frac{I/i_0}{\left(\cot\omega t_1 - \frac{\alpha}{\omega}\right)\sin\omega t_1\,\epsilon^{-\omega t_1\alpha/\omega}}\right]^2 \quad \ldots \quad (26)$$

From Equs. (8) and (26)

$$\frac{CV_{HT}}{i_T} = \frac{2\tau}{(1 - 1/4Q^2)\left(\cot\omega t_1 - \frac{\alpha}{\omega}\right)^2} \quad \ldots \quad (27)$$

The units are ohms, henrys, farads, volts, amperes, seconds.

* The expression $\exp(-x)$ is merely an alternative way of writing ϵ^{-x} and means exactly the same; it is a convenient one when the index is at all complicated.

These Valves make News!

MINIATURE AMERICAN TYPES for AC/DC EQUIPMENT

A complete range of miniature B7G valves is now available for 110 volt or 240 volt AC/DC equipment. All these valves bear American type numbers.

TYPE 50C5

OUTPUT TETRODE for 110v. Supply

Heater Rating	50.0 volts 0.15 amp
Mutual Conductance	7.5 mA/V
Power Output	1.9 watts

TYPE 19AQ5

OUTPUT TETRODE for 240v. Supply

Heater Rating	19 volts 0.15 amp.
Mutual Conductance	4.1 mA/V
Power Output	4.5 watts

TYPE 35W4

HALF WAVE RECTIFIER

Heater Rating	35 volts 0.15 amp.
R.M.S. Input	240 volts max.
Rectified Current	100 mA. max.

DIMENSIONS:—Seated Height 2¾" max.
Diameter 1" max.

TYPE 12BE6

SPECIAL HEPTODE

Supply Voltage	110 volts	250 volts
Heater Rating	12.6 volts 0.15 amp.	
Anode Impedance	0.5	1.0 meg.
Osc. Mutual Conductance	7.5	7.5 mA/V
Conversion Conductance	0.4	0.48 mA/V

TYPE 12BA6

VARI Mu R.F. PENTODE

Heater Rating	12.6 volts 0.15 amp.	
Anode Impedance	0.25	1.5 meg.
Mutual Conductance	4.3	4.4 mA/V

TYPE 12AT6

DOUBLE DIODE TRIODE

Heater Rating	12.6 volts 0.15 amp.	
Voltage Gain	33	42

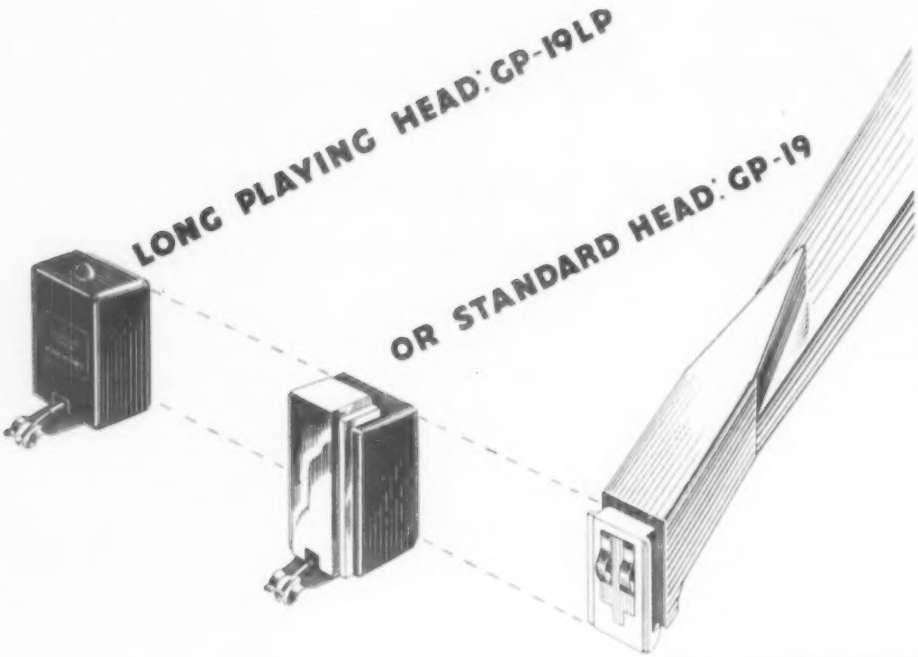
DIMENSIONS:—Seated Height 1¾" max.
Diameter 1" max

BRIMAR

WRITE NOW TO DEPT. 4530
for data sheet on the above valves

TECHNICAL ADVICE SERVICE

STANDARD TELEPHONES AND CABLES LIMITED, FOOTSCRAY, SIDCUP, KENT.



INTERCHANGEABLE ON THE GP20 NEW TRUE FIDELITY PICK-UP

Long-playing micro-groove records are here. And so is the GP.19LP Head, specially made for them. It is interchangeable with the Standard GP.19 Head on the famous GP.20 Pick-Up. The man with a GP 20 and these two heads is equipped for the finest possible reproduction from *any* record—standard or micro-groove, 78 or 33⅓ r.p.m.

GP-20	*Complete pick-up with Standard Head*	£2 10 0 (*plus 21/5 P.T.*)
GP-20LP	*Complete pick-up with Long Playing Head*	£2 10 0 (*plus 21/5 P.T.*)
GP-19	*Standard Head as fitted to GP-20*	£1 10 0 (*plus 13/4 P.T.*)
GP-19LP	*Long Playing Head as fitted to GP-20LP*	£1 10 0 (*plus 13/4 P.T.*)

SOME CHARACTERISTICS

GP-19 HEAD

Output ½v. at 1,000 c.p.s.—5 to 20 times greater than comparable magnetic types.
Range 30-10,000 c.p.s.
Low needle pressure—14 grms.—virtually eliminates record wear.

GP-19LP HEAD

Output ½v. at 1,000 c.p.s.
Response is flat from 30 c.p.s. to 3,000 c.p.s. with a rising characteristic above this frequency.
Needle pressure 7 grams.

BOTH HEADS

Automatic bass-boost without additional equalisers.
Can be fitted to domestic radios.
Needle talk and motor rumble negligible.
Unbreakable and non-hygroscopic crystal element.
Permanent sapphire stylus eliminates needle change.

COSMOCORD LIMITED · ENFIELD · MIDDLESEX

WORLD OF WIRELESS

Anti-interference • Beveridge Committee • Views on Television • U.R.S.I. Meeting

Interference Suppression

PROVISION was made in the Wireless Telegraphy Act, 1949, for the setting up of an Advisory Committee with which the Postmaster General will consult before making regulations prescribing such requirements as he "thinks fit for the purpose of ensuring that the use of the apparatus does not cause undue interference with wireless telegraphy."

The committee has to be appointed from a panel of persons nominated by the Institution of Electrical Engineers, who either "possess expert knowledge of the matters falling to be dealt with" or "represent persons whose interests are likely to be affected" by the regulations. The I.E.E. has now nominated 45 people to constitute the panel from which the P.M.G. has appointed an advisory committee of seventeen members to consider the question of ignition interference and another of eighteen members to deal with refrigeration.

The "ignition systems" committee, of which Sir Stanley Angwin is chairman, and the "refrigeration" committee, include a number of well-known radio personalities and embrace a very wide variety of interests.

It would appear, from the names of the remaining thirteen members of the panel on whose services the P.M.G. will be able to call when regulations in respect of other types of apparatus are to be framed, that electro-medical equipment will be considered at a later date.

B.B.C. Enquiry

THE Broadcasting Committee, which was set up last year under the Chairmanship of Lord Beveridge, to "consider the constitution, control, finance and other general aspects of the sound and television broadcasting services in the U.K. . . . and to advise on the conditions under which these services and wire broadcasting should be conducted after December 31st, 1951 [when the present Charter of the B.B.C. ends]," completed the hearing of evidence at the end of July.

The first meeting of the Committee was held on June 24th, 1949, and during the past 13 months some one hundred organizations and individuals have given oral evidence before the Committee. It is understood that four members of the Committee are visiting North America to obtain additional information on the services in the U.S.A. and Canada.

The Lord President of the Council, Mr. Morrison, recently stated that he hoped the report of the Committee would be presented to him by the end of the year.

European Television

FOLLOWING the meeting in London of the Television Study Group of the International Radio Consultative Committee (C.C.I.R.), at which a preference for a 625-line standard was expressed by the majority of delegates, a meeting was held in Geneva in July.

At this meeting, attended by delegates from Belgium, Denmark, Italy, the Netherlands, Sweden, Switzerland, France, the U.S.A. and the U.K., it is understood detailed standards were established which are to be recommended to countries wishing to adopt a 625-line system.

Television: U.S. Opinion

THE Editor of our U.S. contemporary, *Electronics*, who as a member of the C.C.I.R. Television Study Group recently inspected the television systems of Europe and the United States, gives some general impressions of the visits in the July issue of his journal.

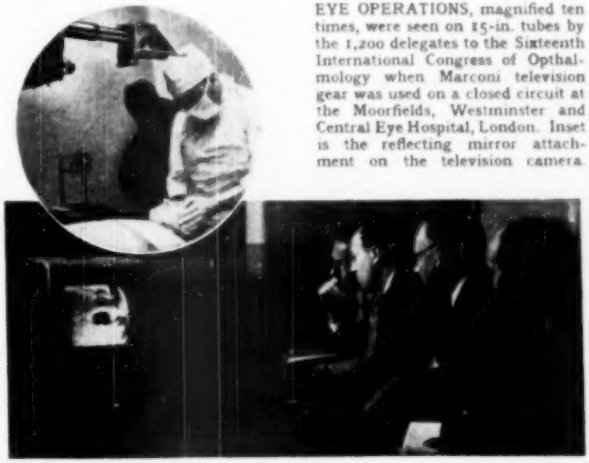
After stating that many of the delegates considered that the U.S. standard of 525 lines, 60 frames, with a 4.25-Mc/s vision bandwidth "is the happiest compromise among the systems demonstrated," he adds "this is not to say that the American television industry leads the world in all respects." He considers that British manufacturers are ahead of the American industry in these respects: First, "the transient response of British television studio equipment, co-axial cables, radio relays and transmitters is much superior", secondly, in the use of the flying spot method of scanning films; thirdly, the C.P.S. camera has several advantages over the image orthicon; and fourthly, in the use of high-power transmitters such as that at Sutton Coldfield.

Among criticisms of the British system are (a) that the use of positive modulation, resulting in white ignition-interference spots on the screen "is more annoying than the black spots of the American system" which, of course, employs negative modulation; and (b) that the use of a.m. rather than f.m. for sound is apt to be noisy.

Scientific Radio

BETWEEN the meetings of the General Assembly of the International Scientific Radio Union (U.R.S.I.), of which Sir Edward Appleton is the President, the work is continued by seven commissions. In addition, at each general assembly national committees submit progress reports on the work undertaken in their own countries in the various fields of scientific radio. The British National Committee for Scientific Radio, which is organized under the auspices of the Royal Society, has nominated seven delegates to the ninth general assembly of the U.R.S.I. which meets in Zurich from September 11th to 22nd.

The British delegates and commissions to which they are especially responsible are: C. W. Oatley (measurements and standardization), who is in the Engineering Laboratory, Cambridge University; Dr.



EYE OPERATIONS, magnified ten times, were seen on 15-in. tubes by the 1,200 delegates to the Sixteenth International Congress of Opthalmology when Marconi television gear was used on a closed circuit at the Moorfields, Westminster and Central Eye Hospital, London. Inset is the reflecting mirror attachment on the television camera.

R. L. Smith-Rose (troposphere and wave propagation), Director of Radio Research, D.S.I.R.; Dr. W. J. G. Beynon (ionosphere and wave propagation), Dept. of Physics, Swansea University; Dr. J. W. Findlay (terrestrial atmospherics), who, during the war, was in the M.A.P. Directorate of Communications Development and is now at Cambridge University; Dr. A. C. B. Lovell (extra-terrestrial radio noise), who was at T.R.E. and is now at Manchester University; W. Proctor Wilson (waves and oscillations), Head of the B.B.C. Research Dept., and Prof. J. Sayers (electronics), who with Prof. Randall and Dr. Boot developed the cavity magnetron.

Meeting Cancelled

IN view of the international situation the Extra-ordinary Administrative Radio Conference which, as mentioned last month, was to be held at the Hague from 1st September, has been cancelled.

Educational Opportunities

PROSPECTUSES and information on special radio and electronics courses are sent to us by a number of educational institutions prior to the opening of the academic year. Among those recently received is the prospectus of the evening courses in telecommunications, and television and radio servicing, issued by the Electrical Engineering Department, of the Polytechnic, Regent Street, London, W.1.

The prospectus from the Northern Polytechnic, Holloway, London, N.7, gives details of both full-time courses in radio and television technology, and evening courses in servicing, telecommunications engineering and electronic measuring instruments.

At the University College, Southampton, the full-time courses include radar, radio engineering and radio operating. There are also part-time day and evening courses in telecommunications engineering and radio and television servicing.

B.B.C. APPOINTMENTS

R. T. B. Wynn, C.B.E., M.A., M.I.E.E., who has been Asst. Chief Engineer of the B.B.C. since 1943, becomes Deputy Chief Engineer responsible under the Chief Engineer (Harold Bishop) for the general control and direction of all the corporation's engineering departments. He joined the B.B.C. as Head of the Engineering Information Department in 1936 after four years at the Marconi experimental transmitting station at Writtle (Chelmsford). He was chairman of the I.E.E. Radio Section for 1949-50.

H. L. Kirke, C.B.E., M.I.E.E., who succeeds R. T. B. Wynn as Asst. Chief Engineer, was also among the Writtle pioneers. He joined the Marconi Co. in 1920 and in 1924 went to the B.B.C. to become, in the following year, Head of the Development Dept., which later became the Research Dept. He will now be responsible for the co-ordination and direction of the technical work of the departments concerned with research, design, planning and installation.

W. Proctor Wilson, C.B.E., B.Sc., M.I.E.E., is the new Head of the Research Dept. of which he was appointed Asst. Head in 1945 on his return from war service. He joined the B.B.C. in 1927, having previously been with the Western Electric Co. He is one of the British delegates to the next meeting of the U.R.S.I.

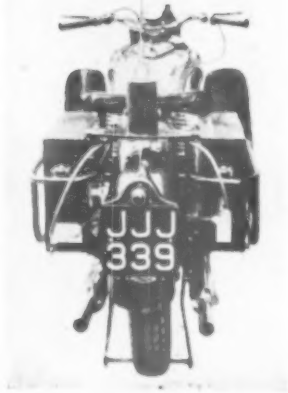
E. C. Drewe, M.I.E.E., is now Asst. Head of the Research Dept. During his twenty years with the B.B.C. he has successively been Engineer-in-charge of the Brookmans Park transmitter, Senior Asst. to the Supt. Engineer (Transmitters), Asst. Head of the Engineering Secretariat and Research Manager.

IN BRIEF

Licences.—12,231,350 broadcast receiving licences, including 406,600 television licences, were current in Great Britain and Northern Ireland at the end of June.

Interference Suppression.—According to our associated journal *Motor Transport*, the principal operators of goods and passenger vehicles have taken the lead in fitting interference suppressors. All petrol-engined vehicles used by British Railways within 60 miles of Alexandra Palace and Sutton Coldfield have been fitted with suppressors—diesel engines do not cause interference. London Transport now employs only 30 petrol-driven buses and these have been suppressed.

B.V.A.—The chairman, J. W. Ridgeway (Ediswan), and vice-chairman, G. A. Marriott (G.E.C.), of the British Radio Valve Manufacturers' Association have been re-elected for the current year.



Canadian Television.—In addition to the equipment which Marconi's are supplying for two television studios in Toronto and two in Montreal the company has been awarded the contract to supply two specially designed television outside broadcasting vehicles for the Canadian Broadcasting Corporation. Each vehicle will be a complete television station equipped with three cameras and providing a radio link with the main transmitter. The total value of the equipment to be supplied by Marconi's is $875,000. Canadian television will operate on American standards; some thousands of Canadians within range of American stations have already purchased receivers. The number of sets sold in Canada during the first half of the year exceeded 15,000.

Duddell Medal for 1950 has been awarded by the Physical Society to D. W. Fry who during the war was at the Telecommunications Research Establishment working on the problems of centimetre-wave techniques. Since the war he has been at the Atomic Energy Research Establishment.

"Heaviside Centenary Volume" to be issued by the I.E.E. will contain a complete record of the proceedings of the meeting of the Institution in May to commemorate the centenary of the birth of Oliver Heaviside. The volume, which will be available to non-members at 10s, will also include "Some Unpublished Notes on Oliver Heaviside."

Reunion.—We are asked to announce that the reunion dinner for those who served in the Test Dept. No. 1 Signals Depot, R.A.F., West Drayton, will be at the Lotus Restaurant, Norris Street, Haymarket, London, W.1, on October 21st. Details are obtainable from H. Coker at 5, Turnpike Parade, London, N.15.

Haifa Volunteer Fire Brigade is seeking quotations from U.K. manufacturers for a 50-watt fixed transmitter and two 20-watt sets for installation on fire appliances. The quotations and descriptive literature should be sent to the Taylor Transport Co., 35, Kingsway, P.O. Box 162, Haifa, Israel.

Valve Vade Mecum.—Copies of the Brans "Vade Mecum" reviewed in our July issue are obtainable from Peter Armstrong, 136 Bickenhall Mansions, London, W.1, at 21s including postage.

Cable Centenary.—The submarine cable, which we would have described in the old days of intense competition between wire and wireless as "our poor relation," is celebrating its centenary. Now that co-operation has largely replaced competition in this field of communications, and radio-like techniques are widely used in all, we can properly offer our congratulations. To mark the event, an exhibition, opening on August 28th, is being staged at the

PLESSEY f.m. transmitter-receivers are being fitted on motor cycles used by the London Metropolitan Police. The equipment is housed in two cases carried on either side of the rear wheel above which is mounted the telescopic aerial. A selective calling system permits any one, or all, of 90 units to be called by the central station which is also being equipped by the Plessey Co.

There has been no change in the position with regard to the withdrawal of overtime working by a section of the printing industry. A slight reduction in the number of pages in "Wireless World" is still unavoidable. All journals printed in London are similarly affected, to a greater or lesser extent, but journals printed in the provinces are not affected. It is greatly regretted that publication of our last issue was delayed.

Science Museum, South Kensington. An interesting and highly informative handbook, "One Hundred Years of Submarine Cables," written by G. R. M. Garratt, of the Museum, is on sale there, or from H.M. Stationery Office, price 2s 6d.

BUSINESS NOTES

Decca Radar, Ltd., has been formed as a subsidiary of the Decca Record Co., to undertake the design, manufacture and sales of Decca marine radar, which in addition to receiving the Ministry of Transport's Certificate of Type Approval has the distinction of being the only British equipment to be approved by the American Federal Communications Commission. The head office is at 1-3, Brixton Road, London, S.W.9, and the factory at Shannon Corner, Kingston By-Pass, New Malden, Surrey. Grp. Capt. E. Fennessey is managing director.

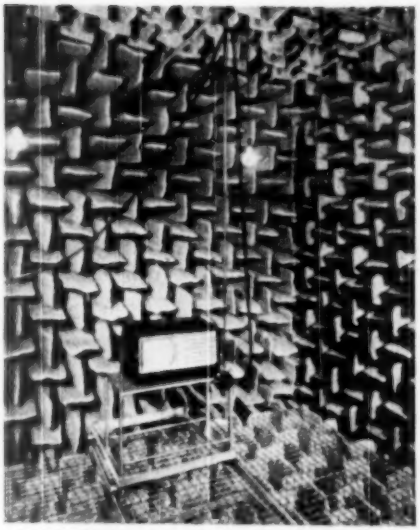
D. W. Heightman, the well-known amateur, G6DH, has, as a result of a divergence of views on a matter of policy, resigned from the board of Denco (Clacton), Ltd., of which he was the founder in 1938 and has been managing director since 1946 when it became a limited company. A. N. Heightman, who was works manager, has also resigned.

Co-ordination of Resistance Production was the theme of a meeting earlier this year in the Philadelphia office of the International Resistance Co. of representatives of resistor manufacturers from Australia, Canada, Denmark, Italy and the U.K. who operate under I.R.C. licence. The U.K. representative was John Goodman (Dubilier).

Marconi's W.T. Co. and Marconi Instruments have now issued a house magazine the title of which is self-explanatory—"The Marconi Companies and their People." It is stated that this will not in any way supersede the "Marconi Mariner" issued by the Marconi International Marine Communication Co.

Ekco search radar equipment, which serves not only for the location of storm clouds but also as an aid to navigation, is to be installed by the British Overseas Airways Corporation in the de Havilland "Comet" and other aircraft operated by the corporation.

R. F. Gilson.—In the report on inductored components shown at the B.S.R.A. Exhibition (p. 257, July issue), we regret the mis-spelling of the name of R. F. Gilson, Ltd., 112, St. George's Road, London, S.W.19.



ECHO-FREE ROOM at the G.E.C. Research Laboratories the walls, floor and ceiling of which are covered with nearly 3,000 "Fibreglass" wedges, each 3-ft long. The sound-"transparent" floor can be seen in this illustration showing a television set undergoing audio tests.

S. American Market.—Empire Products, Ltd., of 229, High Holborn, London, W.C.1, manufacturers representatives and exporters, will be interested to hear from British manufacturers of radio components who are anxious to extend their connections in South America. A director of the firm is visiting Venezuela, Colombia, Peru, Chile, Brazil and Uruguay in September.

A New Zealand client of Jepson, Bolton & Co., of 120, Moorgate, London, E.C.2, is visiting this country and is interested in the purchase of radio equipment other than domestic receivers. Further information is obtainable from the company.

Appointment of Philip Hickson as Director of Buying (radio and television) is announced by the John Lewis Partnership, Ltd. He was for many years technical director of Ardente Acoustic Laboratories.

NEW ADDRESSES

A.B. Metal Products, Ltd., have opened a new factory at Ynysboeth, Abercynon, Glam., South Wales.

Bonochord, Ltd., manufacturers of hearing aids, are now operating from their new factory in Lancaster Road, High Wycombe, Bucks. (Tel: High Wycombe 2136.) The London office is moving from 48, Wigmore Street, W.1, to 45, Welbeck Street, W.1. (Tel.: Welbeck 8245.)

G.R.S.E.—The registered office of the Guild of Radio Service Engineers has been transferred from Bank Chambers, 6, Station Road, Clacton-on-Sea, to 2, Stevenson Street West, Accrington, Lancs. The new general secretary is H. Hill.

"Q-Max" (Electronics), Ltd., are moving on September 1st from 16, Little Turnstile, London, W.C.1, to 95, Villiers Road, London, N.W.2.

Radar Association.—The address of the head office of the association is now 83, Portland Place, London, W.1. (Tel.: Langham 8183.)

T.R.D.—The head office of the Television Retailers' Development Co., and the Midlands T.R.D. Service, Ltd., which were formed as non-profit making organizations to provide dealers with an aerial installation service and advice bureaux, has been transferred from 47, Maddox Street, London, W.1, to 63, Portobello Road, London, W.11. (Tel.: Park 4494.)

MEETINGS

British Institution of Radio Engineers
Twenty-fifth annual general meeting at 6.30 on 27th September at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1, followed at 7.15 by the presidential address of Paul Adorian.

British Sound Recording Association
Presidential address of C. E. Watts at 7.0 on 29th September, at the Royal Society of Arts, John Adam Street, London, W.C.2.

Society of Relay Engineers
"Medium Voltage Feeders and their Associated Transformer Equipment for Long-distance Transmission of A. F. Power" by K. A. Russell, B.Sc., at 2.30 on 3rd October at the Engineers' Club, 17, Albert Square, Manchester, 2.

Hull Electronic Engineering Society
Details of the new Mullard c.r. tube for television projection systems and a description of the associated optical system, coil unit and e.h.t. supply will be given by E. Jones, B.Sc., A.M.I.E.E., at 7.30 on 8th September at the Y.E.B. Showrooms, Ferensway, Hull.

"Frequency Modulation" by E. D. Hart, M.A., A.M.Brit.I.R.E., A.Inst.P., and A. G. Wray, M.A. (Marconi Instruments), at 7.30 on 29th September, at the Y.E.B. Showrooms, Ferensway, Hull.

Measurements with Simple Apparatus

Potentialities of a Common-or-garden Voltmeter

By DONALD ROBINSON (*Londex, Ltd.*)

IN his article "Solving Parallel Problems," in the March issue of *Wireless World*, Mr. D. A. Pollock describes a method of thinking which can be developed and used to solve many other problems besides the particular ones he mentions. He gives an excellent example of how to produce one's own formulae instead of always relying on the text-book and also illustrates the really useful "ratio idea." It is, in fact, this "ratio idea" which enables us to make our measurements with simple apparatus.

Before going any further, it is worth pointing out that the method Mr. Pollock gives for calculating the combined value of two resistances in parallel can be extended by the same reasoning to deal with the much more trying case of three or more resistances in parallel. The formula then becomes:

$$R = \frac{R_1}{1 + \frac{R_1}{R_2} + \frac{R_1}{R_3} + \frac{R_1}{R_4} + \ldots \text{ etc.}}$$

As an example, let us take 3, 4, 6 and 12 ohms. In this case it is easiest to take the highest value, 12, as R_1, and then:

$$R = \frac{12}{1 + 2 + 3 + 4} = \frac{12}{10} = 1.2\,\Omega$$

It is sometimes best, however, to take one of the lower values as R_1. For instance, with 3, 6 and 20 ohms it would be best to take 6.

Measuring Resistance

There are at least two ways by which the "ratio idea" enables resistance to be measured with little more than a voltmeter. One of them is as follows.

Let us first measure some convenient source of volts and then connect the unknown resistance, R, in series with the meter, as in Fig. 1. Clearly, providing R is not inductive and the source impedance is not too high, its value will be in the same proportion to the resistance of the meter (R_m) as the voltage across R is to the voltage across the meter (E_m).

Now we know R_m: it is the "ohms-per-volt" figure of the meter multiplied by the full-scale reading of the range in use—although it would probably be best if the opportunity presented itself to measure

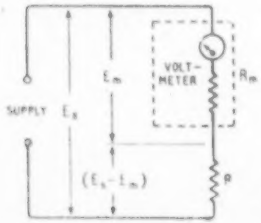
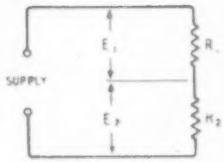


Fig. 1. Simple method of measuring resistance employing a voltmeter.

Fig. 2. Measuring resistance by comparison; an alternative method to that in Fig. 1, for low values.



the resistance of each range accurately, once and for all. We also know E_m: it is what the meter is saying. The voltage across R is the source volts (E_s) minus E_m. Therefore:—

$$\frac{R}{R_m} = \frac{(E_s - E_m)}{E_m}$$

$$\text{or} \quad R = R_m \times \frac{E_s - E_m}{E_m}$$

This is well worth remembering, if only for those occasions when the ohms-range battery dies unexpectedly!

It is advisable to select the meter range that has an R_m nearest to the suspected value of R, and then to find a source that gives a voltage near to, but below, the full-scale reading of the range. It must not, of course, be affected by the load of the meter.

The h.t. and bias voltages of a receiver often provide a good choice of E_s, but if R is not significantly reactive and a meter with a.c. ranges is available the mains can be used, either direct or from between suitable taps on the primary of a mains transformer.

Thus, if the meter resistance is 1,000 ohms-per-volt and R is non-inductive and believed to be between about 50kΩ and 250kΩ you might use the 100-volt a.c. range and the 50 volts obtainable from between the 200- and 250-volt taps on a mains transformer.

Before using a low a.c. range—say under 12 volts—it is best to take into account the method the meter manufacturer has used to minimize the inaccuracy that can arise on these ranges as a result of the variation in the resistance of metal rectifiers at low currents. Some makers avoid the effect by providing a special non-linear scale for low a.c. volts, but this means that the variation in rectifier resistance is high enough compared with the multiplier resistance to affect R_m significantly. Such ranges should not be used for this method below about two-thirds of full scale.

Other makers, however, overcome this difficulty and are able to use one linear scale for all ranges by reducing the ohms-per-volt figure for the low a.c. ranges, often to a tenth of the figure for other ranges. No difficulty will be experienced with these meters, provided the lower ohms-per-volt figure is used in working out the answer and the increased possibility of loading down the source is considered.

Otherwise, the limit of useful accuracy is perhaps

reached when R is either about a fifth, or five times, R_m. A 1,000-ohms-per-volt meter of the latter type with ranges running from 10 to 1,000 volts can thus be used to check resistors between 2kΩ and 5MΩ.

Comparison Method

An alternative method that can be used for lower values and which gives a greater accuracy up to perhaps 100kΩ is that shown in Fig. 2.

In addition to a voltmeter and some volts, a known resistor, R_1, is needed. If R_1 and the unknown resistor, R_2, are connected in series across the supply and the voltage across each is, respectively, E_1 and E_2 and the current is I, then :—

$$R_2 = \frac{E_2}{I} = \frac{E_2}{E_1/R_1}$$

$$= R_1 \times \frac{E_2}{E_1}$$

A noteworthy feature is that the accuracy is but little affected by the shunting effect of the meter or by the accuracy, or otherwise, of its calibration. In fact an uncalibrated meter can be used provided it has an evenly divided scale.

The nearer R_1 is to R_2 the greater the accuracy. If their ratio is not more than 2 or 3 and neither is more than about a quarter of the resistance of the meter, considerable reliance can be placed on the result.

Checking Impedance

The comparison method can also be used to check impedance, and it is generally more accurate than the two-meter method (one for E and one for I) as it is not dependent on the accuracy of calibration. This is particularly likely to be so at 400 c/s or more when the accuracy of many meters falls off.

The accurate measurement of impedance needs careful precautions and finer measuring devices than the ordinary moving-coil meter, but the method we are dealing with has wide use for rough practical checks—for such purposes as testing a transformer for shorted turns by finding its impedance at 50 c/s., and for obtaining an idea of the impedance of a group of loudspeakers in a factory or public building in order to check the matching and see that there are no line shorts or reversed transformers.

As loudspeaker impedance is mostly reflected resistance, the waveform or frequency of the test signal is not of great importance, provided it is steady and well away from the upper and lower resonant frequencies. I have often used one of the whistles with which most radio receivers are only too well endowed.

If the loudspeaker system normally operates at the usual figure of 100 volts, this test can be made at a level hardly audible to any possible listener, and because of this low level a one-watt resistor can be used for R_1, even when the amplifier is rated at hundreds of watts. This is perhaps the most useful test that can be made on a big amplifier system.

An inexpensive and readily obtainable resistor for use as R_1 is the half- or one-watt, 1% accuracy, cracked-carbon type. A set of four—10, 100, 1,000, 10,000—will meet most needs, though for greater accuracy a set of seven—10, 33, 100, 333 . . . etc. —is better.

They can be usefully made up into a small adaptor, wired as in Fig. 3. Switch S_1 selects R_1 and also has two extra positions, E_s and E_m to facilitate tests by the series-voltmeter method.

Thus, if it is found that 10kΩ is not high enough for R_1 the switch can be moved in succession to the next two positions and the value found by the series method. It is best to use for S_2 a push-button or a non-locking key, spring loaded to the E_1 position. It can then be left alone when making a test by the series method.

When first using this adaptor one is inclined to select a hopelessly unsuitable supply voltage, value of R_1 and/or meter range, but as one has then to think in ratios in the way shown by Mr. Pollock to find which way to alter the constants, one soon becomes able to handle with facility both this unit and any other ratio problem that comes along.

Internal Resistance

The internal resistance of a battery, h.t. supply, valve stage or other source is often found by dividing the change in volts by the change in current that occurs when two values of load resistor are connected in turn, i.e. $R_i = \Delta E/\Delta I$. A method of doing this is illustrated in Fig. 4. Here :

$$E_s = I_1(R_1 + R_i) = I_2(R_2 + R_i)$$

$$\therefore \quad I_1R_i - I_2R_i = I_2R_2 - I_1R_1$$

$$\therefore \quad R_i(I_1 - I_2) = E_2 - E_1$$

$$R_i = \frac{\Delta E}{\Delta I}$$

$$\text{or } R_i = \frac{E_2 - E_1}{\frac{E_1}{R_1} - \frac{E_2}{R_2}}$$

Accuracy is likely to be greatest when E_2 is about twice E_1, but it should be remembered that internal heating may change R_i if the current is excessive.

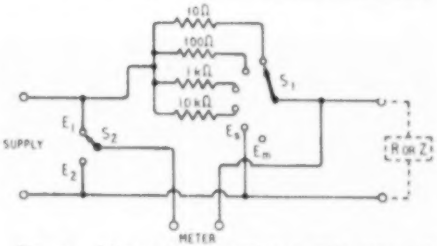
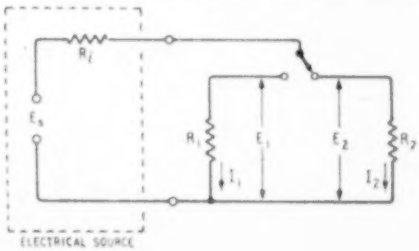


Fig. 3. Adaptor for measuring a wide range of resistance or impedance with the aid of a voltmeter.

Fig. 4. Method of measuring the internal resistance (R_i) of an electrical source, using two load resistors.



It often happens that the internal resistance to be measured is high enough for the open-circuit voltage indicated on one range of a meter to be distinctly different from that shown on another range. In such cases the internal resistance is best found from these two readings only, without the use of load resistors. R_1 and R_2 are then the ohms-per-volt figure multiplied by the full-scale reading of each range.

Amplifier Power Output

Although the rated output of an amplifier or receiver—the so-called "maximum undistorted output"—can only be measured with accuracy if complex apparatus is available, there is a method whereby it can be checked to a practical degree of accuracy with very simple apparatus.

I have found that, except in some special cases we shall come to later, the accuracy is of the same order as that obtainable from visual examination of the output wave-form on an oscilloscope; that is, within about 10%. This order of accuracy cannot always be reached, however, with fixed bias and other special types of amplifiers, so we will begin by considering first the most common class of amplifiers, those employing auto-bias.

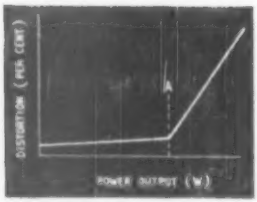


Fig. 5. Curve showing the relationship of percentage distortion to power output in amplifiers using auto-bias.

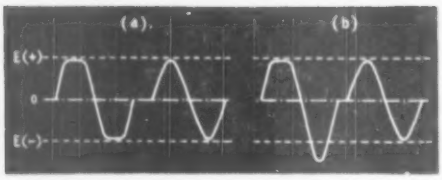
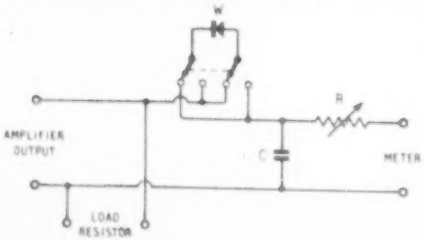


Fig. 6. Amplifier output waveforms, (a) flattening on both peaks, (b) flattening on the positive peak first. E is the peak voltage available at point A in Fig. 5.

Fig. 7. Tester for enabling the maximum output of an amplifier to be measured with an ordinary voltmeter.



Now what is the relationship of percentage distortion to output in such amplifiers? Except in some special cases dealt with below it is always much as shown in Fig. 5. Distortion stays at a reasonably low level until the peak input voltage to the grids of the output valves exceeds the auto-bias voltage. After this point distortion increases quickly, producing the knee shown at point A in the curve. The power at this point can conveniently be termed the maximum output.

The factor used to check this quantity is that the peak output voltage never exceeds that available at point A, i.e., for maximum output. As shown in Fig. 6(a) (we will come to 6(b) later) the waveform at any level above point A is flattened, due to grid current, and there is no increase in the peak value. In fact it often falls.

If therefore we can measure the highest peak voltage obtainable, E, and then find the r.m.s. value of the sine wave with the same peak value ($= E/\sqrt{2}$), square it, and finally divide by the value of the load resistor, R, we obtain the maximum output, i.e.:

$$P_{out\ max} = \frac{(E/\sqrt{2})^2}{R} \text{ watts}$$

The components used in practice are shown in Fig. 7. W is a small stick-type metal rectifier with a voltage rating at least twice the amplifier's output voltage; and, assuming the amplifier's output voltage is in the normal range of 100-120 volts and the meter resistance is 100 ohms-per-volt, C can be about 2μF.

To set up the unit, a source of sinusoidal a.c. (the mains will often, but not always, do) has to be set to the amplifier's nominal output voltage, which is usually 100 volts. The output tester is then connected to this supply and to a meter set to the d.c. range nearest to 250 volts. The resistor R is then adjusted until the meter reads exactly 100 volts. The meter will now indicate the r.m.s. value of a sine wave of the same peak value as whatever voltage is applied to the tester; i.e., $1/\sqrt{2}$ or 0.707 of the peak value.

In use, the unit is connected to the amplifier's output, to the meter and to a suitable load resistor. The last-mentioned can be a heater element adjusted to have a resistance of E^2/W where E is the nominal output voltage and W is the rated output; (don't use lamp bulbs, their R varies with E). The amplifier is now driven by any continuous tone which, it may be interesting to note, need *not* be sinusoidal. The input is increased until the maximum possible reading is obtained on the meter with the switch in Fig. 7 first in one position and then in the other. The square of the lower of these two readings divided by the value of the load resistor can then be taken as equal to the maximum output.

The need for the two readings is shown by Fig. 6(b); if there is any appreciable amount of even harmonics it is necessary to use the reading taken on the half wave that flattens first. Incidentally a difference in these readings indicates a defect if the amplifier is push-pull, for such amplifiers should not have a noticeable amount of even harmonics.

Unless alternative values of R, and perhaps C, are provided, the unit can only be used with the type of meter on the particular range with which it was first set up. In addition the accuracy deteriorates below about half the voltage at which the setting up

was done. This matters little, however, as the amplifier would then only be giving a quarter of its rated power.

The accuracy is also reduced if the distortion/output curve is smooth and without a definite knee. This occurs in varying degree with fixed-bias amplifiers and with auto-bias amplifiers with such defects as an early stage or transformer overloading before the output valves. It is, however, quite easy to detect this state of affairs, as the output meter will not then come to a definite stop as it does with a good auto-bias amplifier.

Readings taken by this method on an auto-bias amplifier exhibiting such properties, or on a class AB_2 or class B amplifier with positive drive, are of little value; but a reasonable indication can be obtained with fixed-bias amplifiers that are not meant to be driven positive by looking for the point at which the rate of movement of the pointer—normally in proportion to the increase in the input level—suddenly slows down considerably. That is, with such amplifiers the pointer does not so much hit the buffers as run into a heap of sand!

I have found it valuable to make up the circuits of Figs. 3 and 7 with some load resistors into one unit for checking R, Z and maximum output.

Recording Air Traffic Control Telephony

Equipment Adopted by the Ministry of Civil Aviation

AIRPORTS coming within the jurisdiction of the Ministry of Civil Aviation are shortly to be provided with sound recording equipment for all radio-telephone communications between air traffic control officers and pilots of aircraft in flight. Development work initiated by the Directorate of Telecommunications, M.C.A., and implemented by recommendations of the International Civil Aviation Organization has been carried out by the Royal Aircraft Establishment, Farnborough, in association with Simon Sound Service who were given the development and production contract. Initially, about 100 installations will be required and the actual manufacture is being carried out by an associated company, Simon Equipment, Ltd. The first production model is already undergoing trials at Prestwick.

The system of recording adopted complies with I.C.A.O. recommendations that the recording medium shall not be capable of being erased or altered without leaving visual evidence of interference (which rules out magnetic recording). Accordingly a direct-recorded embossed track with lateral modulation on standard 35-mm uncoated cellulose acetate film stock is used.

The recording and reproducing heads are of the moving-iron type with replaceable styli. The pickup head can be traversed by hand to select any part of the track, and passages can be played back while recording is in progress.

Approximately eight hours' recording time is provided by one loading of film, which is formed in a continuous loop with a reversed butt joint. After passing the recording stylus, a given point on the film is turned through 180 degrees so that, after traversing the loop, it comes up for recording on the reverse side. In this way both sides of the film are filled with the recorded track, which, incidentally, has a pitch of 0.007in. There are 120 tracks in the width of each side of the film and the time taken from the start to the reappearance of the groove alongside the starting point (after two revolutions from joint to joint) is four minutes.

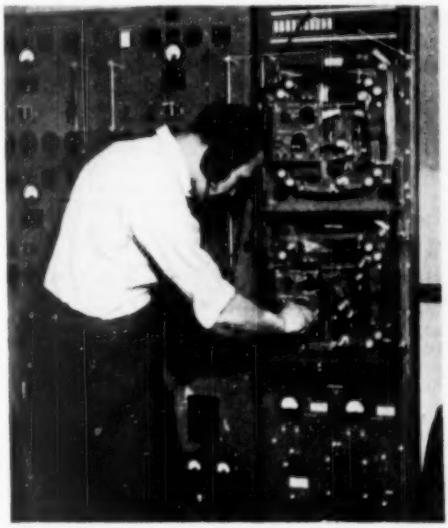
The linear speed is 40ft/min, and, although this may seem low by normal recording standards, the quality and intelligibility of speech recorded by the 0.0015-in radius stylus is more than adequate for the operational requirements of air traffic control. The overall frequency response is within ±4db over the range 200-3,000c/s; ultimately only the band 500-3,000c/s, carrying the principal elements of intelligibility, will be used, and coded time signals will be superimposed on the speech track at 300c/s.

Duplicate recorders are provided and a relay mechanism gives an "instantaneous" changeover (of the order of milliseconds and well within the duration of a single syllable) in the event of breakdown or when the film is full; normally a recorded overlap of about four minutes is allowed.

A voice-operated clutch mechanism can be used to economize film when traffic is slack.

The equipment will be shown working on the Ministry of Civil Aviation's stand at the S.B.A.C. exhibition at Farnborough (5th-10th Sept.).

Sound-recording equipment at Prestwick Airport for continuous monitoring and recording of all radio-telephone conversations between the Control Unit and pilots.



NEW BOOKS

Radio Servicing: Theory and Practice. By Abraham Marcus. Pp. 275; figs. 400. George Allen & Unwin, Ltd., Ruskin House, 40, Museum St., London, W.C.1. Price 35s.

FROM the title the reader might expect a description of the art of repairing radio receivers. What the author presents here is a very comprehensive survey of domestic radio receiver practice, with some notes on faults and service methods. It is all very useful indeed to the novice entering the field of radio service work, but a better title would have been "Domestic Radio Receiver Circuits."

The opening chapter is a "refresher" course on electrical and radio theory, followed by another on components and one on the valve, tracing its development from the diode to multi-electrode and multiple valves. This provides the raw material, as it were, for several following chapters on various aspects of valves. Three chapters on circuitry round off the receiver design section at page 560. Each chapter is followed by a list of revisionary questions.

The chapter on servicing instruments is a curious mixture of academic meter sketches and modern commercial equipment. Three chapters on servicing methods (88 pages) complete the text.

A servicing flavour is introduced into the body of the book by the addition of a section of "Service Notes" at the ends of appropriate chapters, although they are rather in the nature of an afterthought than the primary purpose of the chapter. They summarize the probable faults that can occur in the stage concerned, and are frequently repetitive and generally of a simple nature.

This repetitive tendency pervades the final chapters, which seem to rush through the processes of fault-finding at a breathless speed. A primary dictum that certainly would not be endorsed by a practising serviceman is: first test all valves, irrespective of the symptoms.

The treatment throughout the book is mainly descriptive, with a minimum of mathematics, and the author has a very readable and easily assimilated style, but whereas radio theory is explained in a thoroughly practical manner, the essentially practical subject of service work gives the impression of being treated somewhat theoretically. No attempt has been made to Anglicize the Americanese for this English edition.

Despite the size of this volume, the number of subjects dealt with is so great that some of them receive hardly more than a passing mention, although it is difficult to think of anything that is not mentioned at all.

To the servicing improver who wishes to familiarize himself with receiver design this book contains as much as he can expect to find between two covers. To the student who requires a good readable, descriptive introduction to receiver design it can be recommended.

E. A. W. S.

Sound Reproduction. By G. A. Briggs. Second edition. Pp. 248; figs. 193. Published by Wharfedale Wireless Works, Bradford Road, Ilkley, Yorks. Price 10s 6d.

THE first part of this book deals with loudspeakers and is an extension of the author's earlier work "Loudspeakers."

He has carried out a large number of experiments with loudspeaker cabinets and provides in this volume a wealth of figures and curves relating to every size and shape of baffle—plane, enclosed, vented, pipe, horn, etc. For the most part the results are given in terms of the peaks produced in the speech-coil impedance characteristic, which is not always a criterion of acoustic output; but if one cannot always agree with his conclusions, one is grateful for the evidence, which is not to be found elsewhere in the literature on anything like this broad basis.

Up-to-date information has been added to this second edition and includes such items as the slant-plate divergent lenses of Kock and Harvey for h.f. diffusion. There is also a good new chapter on cross-over networks, with practical design data.

Part II, which deals with recording, has been extended, and more information has been included on magnetic recording, and also on long-playing records. New evidence is produced on the relative merits of sapphire, tungsten carbide and diamond as stylus materials. Questions of stylus and record wear are viewed from all angles and beautifully illustrated by the photomicrographs of C. E. Watts. Surface noise, hum and motor rumble are investigated on a quantitative basis, and the author has something to say on every aspect of recording and reproduction.

Summarizing, this work may be regarded as the personal notebook of a loudspeaker manufacturer of nearly 20 years' standing who has succeeded in retaining the fresh and enquiring outlook of the amateur on high-quality reproduction—the term amateur being used in its original derivation of one who loves his subject.

What the book may lack in the rigour or orderliness of subject treatment usually demanded in a textbook is more than compensated by the writer's entertaining and forthright style. One thing is certain: no reader, whatever his height of brow, will fail to find something instructive or stimulating to thought in this generous collection of facts, dicta and opinion on the reproduction of sound.

F. L. D.

Communication Circuit Fundamentals. By Carl E. Smith. Pp. 401 + x. McGraw-Hill Book Co. Price in U.K. 42s 6d.

THIS book is the second in a series by the same author, intended as a course in radio and other communication engineering. It is self-contained, however, and covers the basic principles of circuits and valves, beginning with matter and energy, electricity, and d.c. circuits, continuing through a.c. circuits, and ending with an introduction to valves and cathode-ray tubes. The treatment is on the whole quite simple, and, being intended especially for home study, each chapter includes examples and exercises, and is followed by a summary of the main points. Nearly 50 pages at the end of the book are devoted to appendices, including lists of symbols and abbreviations, tables, useful formulæ (mathematical and electrical), and analysis of waveforms. There is a good index and full answers to all the exercises.

It would have been a pleasure if it had been possible to [illegible]ed that a book so well and carefully organized for its purpose of instructing beginners had been equally well written. Unfortunately, however, it is very uneven and contains many unnecessary difficulties for the student, of which the following are one or two examples.

"A resistance is said to have one ohm when an emf of one volt causes a current of one ampere to flow. This is a statement of Ohm's Law." In fact, of course, it is a statement concerning a particular system of units. As regards units, the book starts with the hitherto usual mixture of practical and c.g.s. units; then on p. 102, in the middle of a paragraph on skin effect (of all things!) one finds a short table headed "Reduction of Quantity in C.G.S. Units to M.K.S. Units." Neither here nor anywhere else is there an explanation of what this means, but a few pages later there is a sudden transition from maxwells to webers (incorrectly defined), and from centimetres to metres. After some pages of mixed m.k.s. and c.g.s. units, inductance and capacitance formulæ are given in inch units. The subject of units in general is not included.

The author does not hesitate to use terms and ideas to which the reader has not been introduced. In the paragraph on skin effect just mentioned, at least five

important new terms are used, which are defined or explained only in later chapters. The treatment of magnetism is very confusing; and the chapter on series resonance leads to the conclusion that "with a given value of Q, the selectivity will increase as L is made larger." For the most part the treatment is by numerical example, avoiding anything but the simplest algebra; then, without warning the circuit containing R and L is solved in the most uncompromisingly mathematical manner by differential equations; but in the corresponding R and C circuit in the next chapter the author reverts to elementary school methods. Consequently, whereas the current in the inductive circuit keeps on growing for ever, the current in the capacitive circuit soon reaches a definite zero.

It must be recorded, however, that the sections and chapters on circuit networks and theorems are excellent; the treatment is simple yet concise, and includes important matter that is not always attempted at all in elementary books. The use of reactance sketches for qualitative study is a good feature. The chapters on valves and the brief one on the cathode-ray tube are also reasonably free from the type of flaw referred to above.

The imperfections would be less marked if the reader could be assumed to have some knowledge of the subject, and it is suggested therefore that the book would be a good one for students' *revision*. One would, however, also venture to recommend some author's revision.

M. G. S.

Gramophone Speed Conversion

Possibilities of Adapting Existing Types for Long-playing Records

By R. L. WEST, B.Sc., A.M.Brit.I.R.E.

THE recent release of LP records in this country has aroused considerable interest among experimenters. The most expensive single item in the changeover is undoubtedly the motor. Some people feel they would like to try out LP before scrapping their existing motor and buying a new dual-speed type. Others just can't afford it after buying a new pickup and a couple of LP records! Either way, the idea of converting the existing motor appeals, so here are a few notes on the subject.

Only simple modifications are envisaged in this article and only simple hand tools will be needed. Readers with well-equipped workshops have unlimited scope for their talent, and I expect their projects are already well under way.

All governor-controlled types should be convertible to dual-speed operation. This covers the commutator types—d.c. and universal, as well as the brushless induction motors and the eddy-current motor. Theoretically the commutator type would be the better, since the torque is almost independent of speed, whereas most induction motors show rather less torque at the lower speed.

Those without governors are generally synchronous motors, and speed, usually 3,000 or 1,500 r.p.m., depends on the supply frequency. Rim-driven synchronous motors can be converted to 33⅓ r.p.m. by fitting a smaller motor pulley, but dual speed involves skilled engineering design.

With a 33⅓ r.p.m. stroboscopic disc on the turntable (a stop watch for the unfortunates on d.c.), see if the speed adjuster will go far enough to reach the low speed. This may entail grub screw adjustments beneath the turntable, or may necessitate moving the whole governor bodily along its spindle a short distance *towards* the friction pad, or even forcing the pad through its holder to make it, say $\frac{1}{16}$ inch longer. It is usually just possible to get both speeds within the limits of travel of the speed regulator arm or screw. If this cannot be done, then the remainder of this article acquires only academic interest!

At 33⅓ r.p.m. the turntable speed will probably prove to be far from steady. A number of causes can be found, but first a little theory, starting with the formula

$$\text{Change of angular velocity} = \frac{\text{Driving torque} \times \text{time}}{\text{Moment of inertia}}$$

At 33⅓ r.p.m. each tooth is transmitting the drive for 2·34 times as long as at the higher speed. The driving torque is more or less the same, the inertia identical, hence much larger speed changes due to imperfections of gear shapes or meshing are to be expected.

When rotating, the turntable has kinetic energy proportional to $(\text{r.p.m.})^2 \times$ moment of inertia. At the lower speed this is reduced to less than ⅛th of its 78-r.p.m. value.

Regular and irregular abstractions of energy take place due to variations in friction of the governor bearings, gears, and the pickup itself, thus producing further speed changes. This can be countered by increasing the moment of inertia of the turntable by a factor of 2·34 times from the first point of view, and 5.5 times from the second—hence 5.5 times, to be on the safe side!

Now the moment of inertia of a circular flat disc—our turntable—equals $\frac{1}{2}\,mr^2$ where m is its mass and r its radius. To increase its inertia either m, r, or both can be increased. If the loading is evenly distributed and the diameter unchanged, the new

Fig. 1. Section of inverted turntable, showing effect of surface tension in holding the level of lead above the height of the rim.

weight will have to be 5.5 times the old. If the loading is arranged mainly near the outside of the turntable, less will be needed since 1lb, 4in from the centre, is as effective as 4lb, 2in from the centre. I favour, however, the first way, since the heavier turntable will be relatively immune from vibration in any other direction as well.

Adding the Weight

Lead is probably the most useful material for this purpose, since it can be melted quite easily over a gas-ring. A layer on top of the turntable is attractive, since it puts the magnetic pickup farther from the steel turntable. This will need machining on the upper face and the spindle will have to be lengthened—a major engineering feat. It is quite easy, however, to put 8-12 lbs of lead underneath the standard 12in turntable.

First, drill the turntable to take six 6 BA countersunk brass bolts. Use the radial ribs and then there is no fear of the heads projecting. Tin the visible part of the bolt and the nut, and when cool smear on more flux to make sure the lead will adhere properly. Invert the turntable and level it carefully on a stone or concrete floor—firmly, because it is very heavy once the lead is poured in. If a blowlamp is available the lead need only be just above its melting point when poured. The blowlamp is to keep the surface molten long enough to allow it to run perfectly level. The lead will finish neatly at the edge of the turntable (*not* tinned) up to ¼in above the level of the rim, due to surface tension. This neat finish minimizes the amount of balancing necessary. If the centre boss is an alloy casting, be careful not to overheat it. In the absence of a blowlamp, the lead must be made much hotter, skimmed more thoroughly, and poured as quickly as possible. Preheating the turntable would obviously help too.

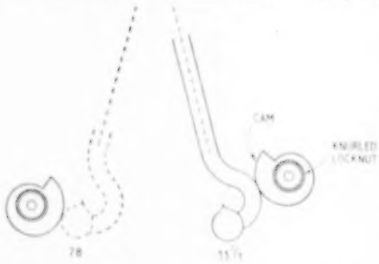


Fig. 2. Pre-set cam stops facilitate a quick and accurate change of speed.

Illustrating the method of testing the turntable for balance.

After cooling, place on the spindle, rotate and check for flatness. If out of true, remove, invert on to a firm surface and a judicious hammer blow on the lead, about a third of the way out from the centre on the correct radius, will do the trick.

Balance is important since it will affect the speed unless the spindle is perfectly vertical. Even then, it may rock the motor on its rubber mounting, producing an effect like a "swinger" record. Mount the turntable on its spindle and tip the whole motor till the spindle is approximately 45° to the vertical. Holding the motor in both hands, rock it to and fro sharply about the axis of the turntable. This leaves the turntable almost stationary in space, but rotating in its own bearings. The heaviest point gradually finds its way to the bottom. Mark it with chalk. Check it by causing it to descend from either side in turn. This will give a more accurate position. In order to decide roughly how much lead to remove, stick various lumps of lead, in turn, on to the turntable with Plasticine, at a point diametrically opposite the mark and repeat the rocking process. Finally drill out some lead and repeat. If persevered with, it shows a sensitivity of less than 1 gram at the periphery, even if 13 lb of lead are run in.

Success will also depend upon very careful attention to the lubrication of governor, gears and bearings. Some concern was felt for the extra loading of the turntable vertical thrust bearing, particularly the type that sits on a $\frac{1}{16}$in ball. No evidence of failure of the lubricant has been observed, but the addition of colloidal graphite, or replacement by one of the extreme-pressure car rear axle lubricants is recommended.

Whilst on the subject of lubrication, a further point arises. Due to the increased weight, the turntable tends to jam on the taper seating of the spindle, making removal difficult and increasing the risk of distorting it during removal. A smear of graphite-loaded grease covering the full length of the taper will be found advantageous.

Due to the increased inertia, the turntable takes quite a time to settle at the selected speed, so that some system of pre-set stops could be devised with advantage. For the moving-arm type of speed adjuster, a couple of snail-shaped cams anchored down to the motor baseplate with knurled nuts is one simple solution.

Really accurate assessment of the final result is quite complicated and something on the lines of the method described by E. W. Berth-Jones in the December 1949 issue of *Wireless World*, or the method described in *Electronics*, July 1950, would be necessary. A useful estimate of success or otherwise can be obtained by setting the speed to 33⅓ r.p.m. and placing on the turntable any 78-r.p.m. frequency record having bands of constant frequency in the range 1,000–2,000 c/s. Centralize the record accurately by watching carefully for lateral motion of the pickup. When satisfied with the centring, listen to the reproduced tone. If no "wow," flutter, or irregular waver is audible, then it is safe to assume that no trouble from this source will be experienced when listening to music.

THE "BELLING-LEE" PAGE

Providing technical information, service and advice in relation to our products and the suppression of electrical interference

The National Radio Exhibition Number

In under a fortnight many readers of this page will be visiting the Radio Exhibition at Castle Bromwich. We are confident that a fair proportion of them will visit us on stand No. 71. Right hand side, the stand surmounted by a "Sky-tower" bearing a "Multirod," the whole erected as high as the hall will allow.

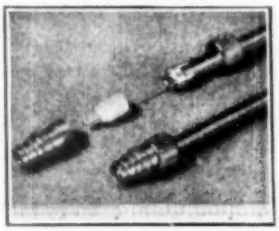
In general our efforts will be directed towards selling aerials, television aerials in particular, for the manufacture of which we have recently purchased an additional factory. By the time the exhibition opens we will have approximately 50,000 square feet of floor space devoted to aerial manufacture.

Television Aerial Conversion Kits

These will be made available just as soon as the frequencies of new transmitters have been confirmed by the B.B.C. It should be remembered that the frequencies of Sutton Coldfield were changed about a fortnight before it opened. The prices of aerial conversion kits will be kept as low as possible, and we hope to be able to show visitors to our stand, just what the kits will look like.

Television Demonstration Aerials

In view of the rapid expansion in the B.B.C. building programme and the hope of two new stations within a year, many visitors will be interested in the new "Belling-Lee" kit to enable television demonstration aerials to be erected temporarily and quickly.



Universal Coaxial Plug

It is expected that "Wireless World" readers will be more interested in our better quality components, and we hope they will all like our new universal coaxial plug L.734/P. This fits all "Belling-Lee" coaxial sockets and

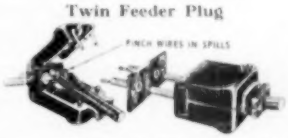
termination boxes, and accepts coaxial cables from 5/32 to 5/16, covering television feeders for domestic purposes with impedances from 50 ohms and including 72 ohm semi-air-spaced.

It is the first "Belling-Lee" plug that, when the writer took it apart for the first time, half of its "innards" didn't find their way under the desk and into trouser turn-ups.

It is easy to load, as the soldering is done before assembly.

This plug replaces three others, which we feel to be a really useful contribution towards standardisation. There may be a new socket and there certainly will be a new aerial termination box incorporating novel ideas.

Twin Feeder Plug



We are conscious that although we have, for long enough advocated the use of 80 ohm balanced feeder, we have been dilatory in offering a really suitable twin plug at a competitive price. At last we believe we have something that will appeal to most users. Something cheap, easy to load, and suitable for the purpose. A termination box to take this plug will also be shown for the first time.

Electrical Interference with Television

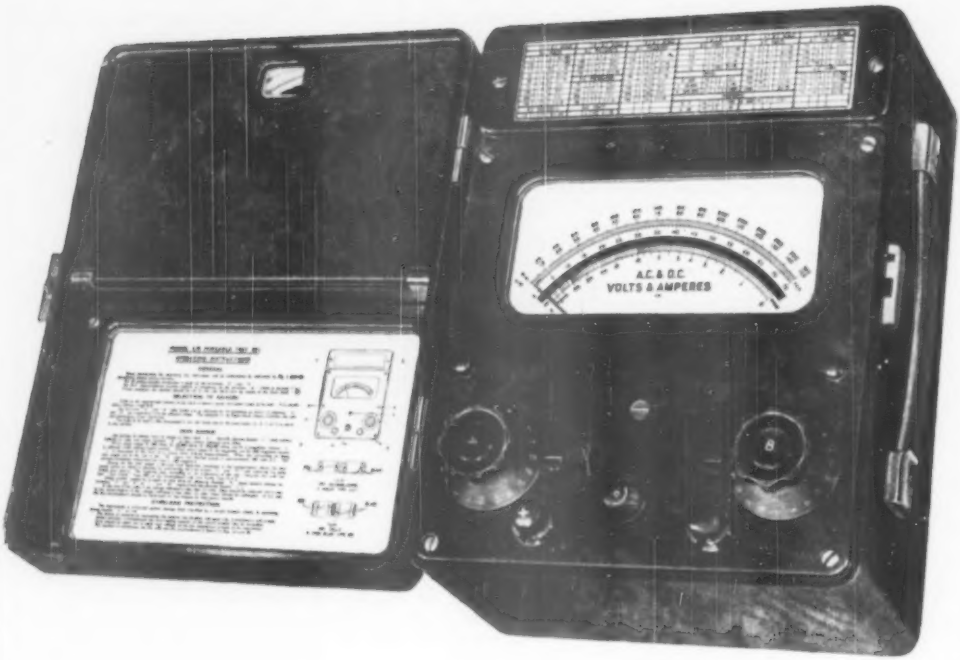
It is generally appreciated that the most troublesome form of interference is that caused by motor cars, but there are cases of interference from small electric motors, and this can be very annoying when it does occur. The suppression of such interference *at the source* does not present much difficulty, but there is little that can be done at the television receiver. Once the interference gets out on the line, it is quickly radiated and re-radiated, and may be picked up by some receivers even when the aerial is well outside the normal interference field, and correctly balanced.

We do want to emphasise that, so far as we know, there is at present no suitable set lead suppressor of any make which will be of much practical use at television frequencies.

We have said this before, but we still have cases where radio dealers have sold the well-known L.300 set lead suppressor, most efficient on broadcast frequencies but really not worth while for television. There may have been some confusion because we claim the L.300 suppressor to be useful from 10 to 2,000 metres. Readers will appreciate that there is a big difference between 10 metres (i.e., 30 Mc/s) and 41.5 Mc/s, the lowest frequency used for television. It should be realised that the usual flex lead suppressors L.301 and L.1174 are normally not effective at television frequencies. "Belling-Lee" are continuously working on this problem and hope to produce a range of suppressors effective at these frequencies.

Where interference is really serious the most sound advice is to erect the best possible aerial as high as practicable, no matter how close the site may be to the transmitter. This may involve the use of attenuators but the signal-to-noise ratio may be greatly improved.

BELLING & LEE LTD
CAMBRIDGE ARTERIAL RD., ENFIELD, MIDDX., ENGLAND



The WESTON S.75 Multi-Range Test Set

53 Ranges with Rotary Switch Selection

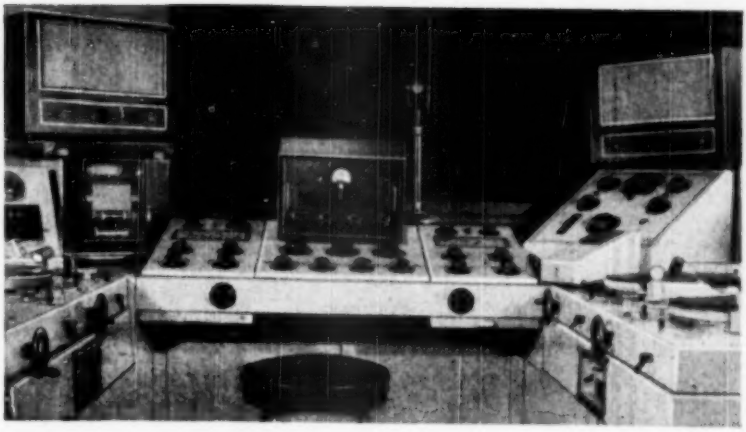
This uniquely comprehensive Test Set has 53 ranges for measuring A.C. and D.C. current and voltage, resistance and insulation. It is completely self-contained, with internal batteries to provide power for the ohms ranges and self-contained power pack for insulation measurement at 500v. Selection is carried out by two 20-position switches. A fully-protective safety device is fitted and is operative for forward or reverse overload. The 150-division 6in. scale is uniformly divided and is fitted with an anti-parallax mirror. The set is enclosed in a handsome bakelite case and fully complies with B.S.S. No. 89 covering first-grade instruments. Full details of the ranges covered, and of the complete specification, will gladly be supplied on request.

SANGAMO WESTON LIMITED

ENFIELD, MIDDLESEX

TELEPHONE: ENFIELD 8434 (6 LINES) AND 1242 (4 LINES)
TELEGRAMS: SANWEST, ENFIELD

DEPOTS AT
Glasgow, Newcastle-on-Tyne, Leeds, Manchester, Wolverhampton, Bristol, Liverpool, Nottingham, Southampton, Ipswich and Brighton.



Control cabin for stereophonic transmission. The only equipment additional to that of a standard cabin consists of the two loudspeakers on the right and left and the central control desk between them.

Improved Stereophony

French Broadcast Using Extra Facilities for Simulating Displacement

By E. AISBERG (Editor, *Toute la Radio*, Paris)

THE first broadcast of stereophony, the system in which sources of sound are restored to their relative positions in space, took place in France on June 19th, 1950. The transmission was made simultaneously by two chains of French broadcasting stations, the Parisian and the Paris-Inter.

To make use of this transmission two receivers were needed. For some days before it took place, the broadcasting authorities made frequent announcements, urging friends to join forces in small groups so as to receive it under optimum conditions. To obtain these, it was explained that two receivers should be placed from 5 to 7 feet apart, with the axes of their loudspeakers converging at a very small angle; the listeners should be at the apex of an isosceles triangle with the sides some 7 to 10 feet long, the base being a straight line joining the two loudspeakers. It was also necessary that the receivers should be adjusted to give the same volume of sound and that their response should be matched as nearly as possible by means of the tone controls.

Lastly, it was strongly recommended that listening should be done in a darkened room, or at any rate, with the eyes closed, in order to prevent any conflict between aural and visual impressions. This point was found to be of very great importance.

At 8.50 p.m., the programme began with an opening speech by René Clair, of French film fame, who had undertaken the task of producing it. After briefly reminding listeners of the conditions required for hearing the transmission properly, he went on to the reproduction of a series of sounds, which showed the acoustic possibilities of the new technique.

The listener's ears could follow a train as it started, gathered speed and crossed from left to right; troops, headed by a band, appeared to march from one side to the other of the room in which he was sitting; the sounds of footsteps going quickly up a spiral staircase could be followed. In each of these examples the ears "pin-pointed" the source of sound readily and very exactly. The impression of movement was strikingly realistic.

Next, listeners were regaled for more than an hour by the production of an unpublished play of Théophile Gautier's, *Une Larme du Diable*. The new technique proved particularly suitable for the reproduction of this piece, in which the author gives speaking parts not only to men and women, but also to God, the Virgin Mary and a number of inanimate objects. The sounds were heard coming now from one direction, now from another, exactly as the author had intended. It must be recorded that the success of this part of the programme was due in no small measure to René Clair's personal touch.

The idea of making reproduction reconstitute the spatial relations of sources of sound is by no means new. It is well known that, provided it does not come from a point immediately in front of or behind the head, the brain determines the direction from which a sound arrives mainly through its differing intensity at the two ears. In other words, the appreciation of what we may term acoustic depth is essentially a product of binaural hearing. In the same way, the visual sensation of depth, which allows us to see objects standing out in relief, depends chiefly upon the simultaneous use of two eyes, the

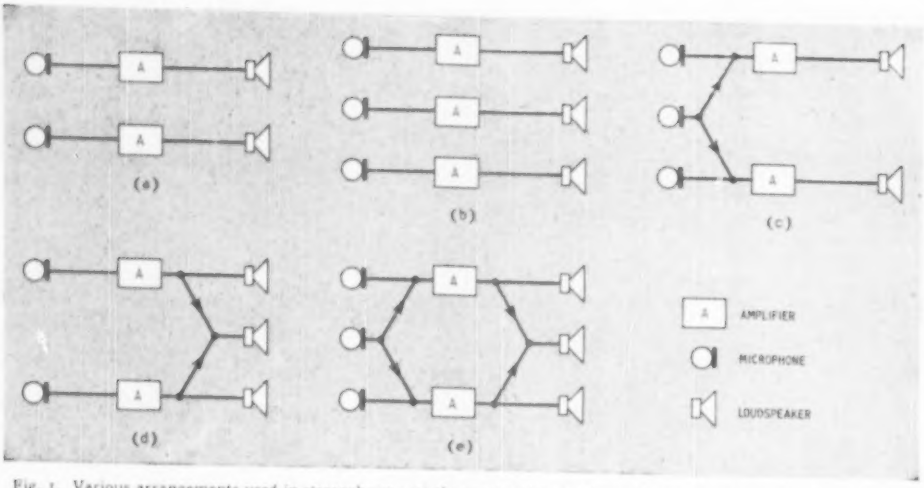
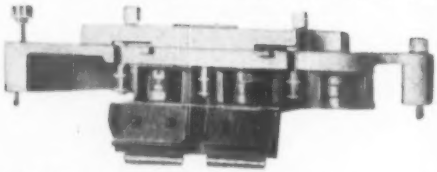


Fig. 1. Various arrangements used in stereophony : (a) the most widely used two-channel system ; (b) three-channel system designed to avoid the dead-spot found mid-way between the outer microphones or loudspeakers ; (c), (d), (e) two-channel systems using three microphones and three loudspeakers either separately or at the same time.

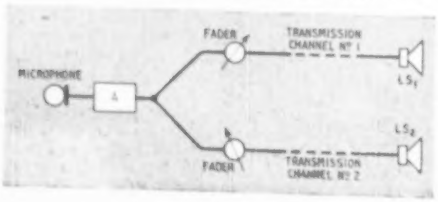
angle of convergence enabling the brain to determine distances.

When listening to broadcasts made by ordinary methods we would be quite satisfied if we used only one ear, because all the sounds which reach the microphone are reproduced by the single small surface of the loudspeaker diaphragm. The use of a number of loudspeakers connected to the same output would make no difference. There is only one way of restoring the directions of sound-sources in reproduction and that is to use two loudspeakers fed by the outputs from two separate channels; the differences between their respective volumes then serve to "place" the sounds.



The two recording heads and the erasing head for double-track tape. One track "lags" 14 cms behind the other, and this relationship remains constant both during the recording and during the play-back.

Fig. 2. An electrical method of simulating displacement of a sound-source in the process of reproduction.



The problem of stereophony (Greek *stereos*, solid) has provided material for a vast amount of research work. Clement Ader, who did such fine pioneering work in the field of aviation, made one of the first practical attempts as long ago as 1881, when he used his "*théâtrophone*" for the transmission of operas over telephone lines. But one of the most striking experiments was that made by the American Telephone and Telegraph Company on April 27th, 1933, when a concert given at Philadelphia was reproduced in a Washington hall by means of a two-channel system. Sounds were picked up by two microphones on the right and left of the orchestra and sent, with suitable amplification, to two loudspeakers similarly placed in the Washington hall.

What may be termed the acoustic perspective was faithfully restored in the reproduction. When the producer walked across the stage, speaking as he went, from one microphone to the other, the listeners in Washington could follow his movements as easily as if a single loudspeaker had been moved about on the stage of the hall in which they were sitting.

An analysis of the technical details of the experiment and of the conclusions which might be drawn from it formed the subject of a series of articles in the *Bell System Technical Journal* for April, 1934. An important point emerging from these is that a number of transmission links of different kinds (see Fig. 1) were tried out. The best results, however, appear to have been obtained with a two-channel system. With its faithful reproduction of the constantly changing positions of the sources of sound, such a system is perfectly adapted to all direct transmissions from theatres or concert halls; but it does not lend itself to those electrical artifices to which the presentation of items specially prepared for broadcasting owes so much of its flexibility.

A completely different system can be conceived in

which sound-sources would be made to change their positions by artificial methods of an entirely electrical nature. As shown in Fig. 2, a system of this kind uses only one microphone, the resulting modulation being distributed to two transmitting links by means of suitable faders. At the receiving end two loudspeakers are required, placed at a suitable distance from one another. The source of sound will then appear to move, in accordance with the relative volume from each loudspeaker, to points on an imaginary line between the two. When one loudspeaker is silent and sounds are coming only from the other, the listener's ears place their source at the position occupied by the latter. When the volume from both loudspeakers is equal, the source of sound appears to be at a point midway between the two. Any other variation in their relative volumes makes the source of sound appear to be at a corresponding point between the two loudspeakers.

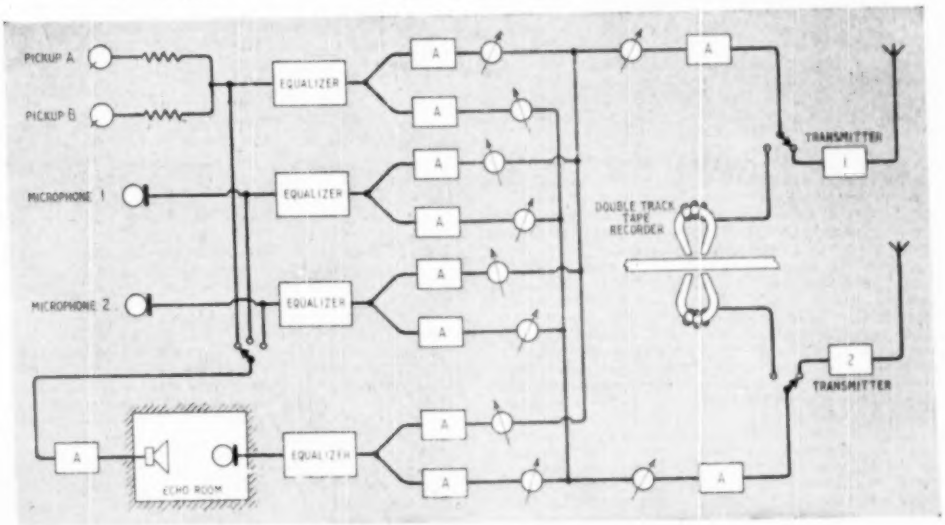
Working on these lines, a controller with his fingers on the knobs of the faders can, at will, make the voice of a broadcaster not moving an inch from one position in the studio, seem to the listener to come from any point between his two loudspeakers. It is not difficult to see that the system lends itself readily to the production of a vast variety of sound effects; in particular the position of the source of sound may be changed instantly from right to left, or *vice versa*. On the other hand, such a system can make no worthwhile use of a number of sources of sound in different positions, for all sounds, no matter whence they originate, are picked up by one single microphone.

The outstanding merit of the improved system of stereophony, due to José Bernhart and Jean Wilfrid Garrett, with which the French broadcasting authorities have recently experimented, is that it combines all the advantages of that tried out some years ago by the American Telegraph and Telephone Company with the facilities for deceiving the ear offered by the system using a single microphone and two transmission channels.

In the improved system a number of microphones

J. W. Garrett (left) and J. Bernhart (right), the engineers responsible for the system, at the control desk.

Fig. 3. Block diagram showing the complete layout used in the Bernhart-Garrett process. The number of pickups and microphones may be increased as required. It will be seen that sound effects from the pickups, as well as the outputs of the microphones, are fed to both channels on the principle of Fig. 2.



may be used; but transmission takes place on two channels only. The basic feature of the system is that the output of every microphone is fed through faders to both channels. Thus either of the listener's loudspeakers can be made to receive at will a suitable "ration" of the output of any microphone.

The less active the controller, the more closely does the working of the improved system resemble that of the old A.T.T.C. stereophonic system. Hence, it is readily adaptable to direct transmission from theatres and concert halls. On the other hand, when the controller wants to show what he really can do, he can make sound-sources which are in fact fixed, appear to move about it any way that he fancies—and he can do this with speed and flexibility that it would be difficult to match.

During the transmission of *Une Larme du Diable* four microphones were in use. The effect of "depth" was produced by means of an echo room. By these means an utterly amazing acoustic perspective was brought into being, with no sacrifice whatever of classic production methods.

The broadcast on June 19th was recorded. With this in view the modulation of the two channels was recorded simultaneously on two sound-tracks on the same magnetic tape. In this way perfect synchronization was ensured during the replay.

It is to be hoped that further experimental transmissions will take place to assist the development of the new system. In this way listeners will make the pleasant discovery that it is not for nothing that Nature has provided them with two ears.

SHORT-WAVE CONDITIONS

July in Retrospect : Forecast for September

By T. W. BENNINGTON
(Engineering Division, B.B.C.)

DURING July the average maximum usable frequencies for these latitudes were slightly lower, both by day and night, than they were during June.

Day-time working frequencies for long-distance communication were relatively low, and conditions were very seldom favourable on the higher short-wave frequencies. The 28-Mc/s amateur band, for example, was almost unusable for communication to North America, and even in more southerly directions did not appear to give very good results. Frequencies somewhat lower than this were, however, very frequently usable in north-south directions, though 20 Mc/s was about the highest useful frequency for east-west communication. Medium-high frequencies were usable over a large part of the day and over most paths. 15 Mc/s was regularly receivable till well after midnight.

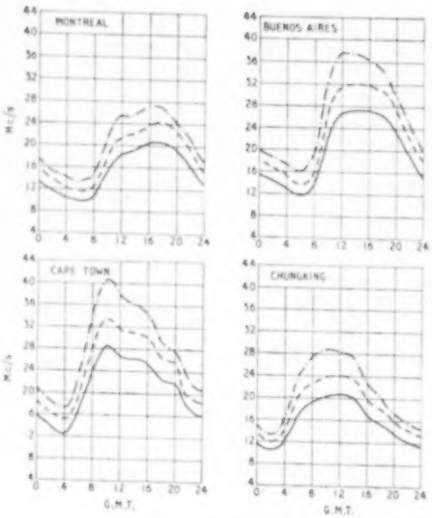
Sporadic E continued to be prevalent, though that with high critical frequency seemed somewhat less prevalent than during June. On the 28-Mc/s band "short skip" contacts with European countries appeared somewhat less frequent than during June. Occasionally, however, distant Continental stations on frequencies up to 50 Mc/s were heard here, and their signals no doubt came in by way of Sporadic E. On a few occasions, nearer Continental stations on 90 Mc/s and on 40-46 Mc/s were heard, most probably by means of tropospheric refraction.

Sunspot activity was about the same average level as during last month, and has now decreased by approximately one-third since sunspot maximum.

There was more ionospheric disturbance during July than during the past few months. Of the several prolonged periods of disturbance which occurred the most severe were those of 4th-6th, 12th-14th and 25th-26th. Only two Dellinger fadeouts were reported, the most severe of these occurring at 1610-1705 on 12th.

Forecast.—There should be a considerable increase in the day-time m.u.fs and a small decrease in the night-time m.u.fs during September, as compared with those for August.

Day-time working frequencies for long-distance communication should, therefore, be fairly high, though it is not expected that frequencies as high as 28 Mc/s will often be usable over east-west paths except, perhaps, towards the end of the month. Over north-south paths, however, such frequencies should be usable almost regularly. Medium-high frequencies should remain usable for a large proportion of the total time and frequencies below about 10 Mc/s should seldom be really necessary at night.



Working frequencies for medium-distance communication will be somewhat lower than during August, both by day and night, and such communication will be by way of the E and F_1 layers for only a short daily period. There should be a considerable decrease in the prevalence of Sporadic E, though some medium-distance communication on the higher frequencies by way of this medium may still be possible. There is often an increase in ionospheric storms during September, and periods of disturbed conditions are, therefore, to be expected.

The curves indicate the highest frequencies likely to be usable over four long-distance circuits during the month.

RC Oscillators

Explaining Why They Are Not Just the Poor Relations of LC Oscillators

By "CATHODE RAY"

MOST of the books on radio explain inductance-capacitance (or LC) tuning at great length and either omit resistance-capacitance (RC) tuning altogether or give it rather scanty notice. Consequently some readers, who are more or less familiar with the theory of the normal LC tuned circuit, are somewhat mystified that apparently similar results are obtainable without inductance. The puzzling aspect is that in the LC circuit these results depend on the peculiar ability of inductance to store energy and to cancel or neutralize capacitance at one particular frequency, whereas resistance can do neither of these things.

The resemblance between the two systems is, in fact, only partial. One cannot with RC circuits do everything that one can with LC circuits. On the other hand, for some purposes RC tuning has advantages over LC tuning. They are not simple equivalents. The fact that there is a resemblance at all is very interesting, but it should not be pressed too far.

The use of RC circuits for obtaining selectivity has been explained quite recently by J. McG. Sowerby† so we shall concentrate now on oscillators. The essential heart of an oscillator is an amplifier, because of its being able to give an output at least as powerful as the input, so that by connecting one to the other in a suitable manner the amplifier can be made to keep itself going; in other words, can oscillate. A transformer by itself, for example, is unable to do this; because the output power is always less than the input. The first condition for keeping oscillation going, then, is *output at least as great as input.*

The second is that the *output must be in phase with the input.* The output at the anode of a single-valve amplifier is in phase opposition to the input at its grid, so connecting anode straight back to grid does not make an oscillator. Some device such as a transformer is needed for reversing the phase. The tuned-anode tuned-grid oscillator is only apparently an exception; actually the phase reversal system is there, though it is mixed up with the frequency-determining parts of the circuit.

The two conditions for oscillation are not necessarily confined to one frequency at a time, but it is usual for them to be. The LC tuning circuit is particularly effective in keeping oscillation definitely to a single frequency, because it exerts a very strong control on both the conditions for oscillation. Both amplitude and phase are altered more or less sharply when the frequency is shifted from resonance, as shown in Fig. 1.

Fig. 2 is a simple and well-known example of how the LC circuit can be incorporated in the amplifier, with a back-coupling or retroaction coil L_r to apply part of the voltage developed across LC to the grid in opposite phase. If L_r is adjusted so that the two conditions are only just fulfilled at the frequency of resonance, then it is clear from Fig. 1 that at any other frequency, even if it is only slightly different, the output is likely to fall below the critical amount

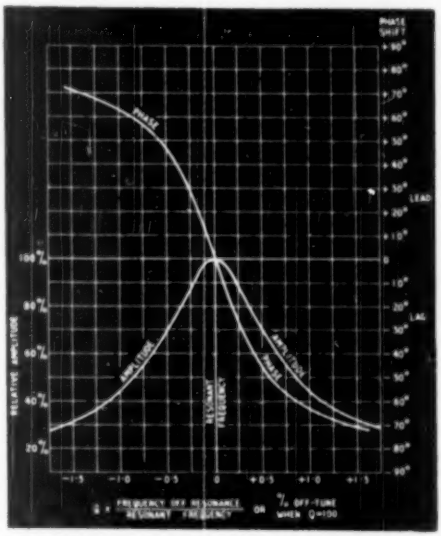


Fig. 1. Graphs of amplitude and phase angle of voltage developed across a parallel resonant LC circuit when fed from a source having infinite resistance. They approximately represent the results in a circuit such as Fig. 2 when the valve is an r.f. pentode.

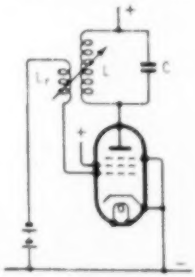


Fig. 2. Very simple LC oscillator circuit, in which the purpose of L is (i) to reverse the phase and (ii) to reduce the voltage developed across LC by the same factor as the valve amplifies, making the voltage received by the grid equal to that necessary to produce the voltage.

† *Wireless World*, June 1950, p. 225.

needed to maintain oscillation, and the phase will be right off.

Fig. 2 and its modifications are very simple and convenient, except that at low frequencies the amount of inductance required demands an enormous number of turns of wire and/or an iron core which introduces the objectionable feature of non-linearity. So at the low end of the frequency scale it is much better to use resistance, which is cheap, linear, easy to vary, and does not pick up hum so readily. But at first sight a ban on inductance seems to raise considerable difficulties. Gone is the convenient transformer method of phase inversion. Gone, too, are the sharply discriminating characteristics shown in Fig. 1. Connecting the output device on the cathode side of the valve instead of the anode would certainly make the phase right for the grid, but would also reduce the output voltage below the input voltage (see theory of cathode follower), so is ruled out on that ground.

If we are obliged to stick to a single valve, then the qualifications of our RC system must be these: it must be capable of shifting the phase of the valve's output by 180° without attenuating it more than the valve amplifies.

A simple combination of one R and one C can be used to cause a phase shift of anything between (but not including) 0° and 90°. In Fig. 3, if R and X_C (the reactance of C) happen to be equal, then the voltage V_R across R is 45° ahead of V, the applied voltage, and V_C is 45° behind it. And V_R and V_C are both $1/\sqrt{2}$ (about 71 per cent) as large as V. If R is made smaller relative to X_C, say by reducing C or the frequency, the phase lead of V_R is increased, but the magnitude of V_R is inevitably reduced. The lead can only be increased to 90° by making V_R zero, when it isn't any good to anybody. Similarly with V_C.

Suppose, however, that we apply V_R (say) to another RC circuit; the output across R in that circuit will lead V_R, and hence lead V by a greater angle, at a further sacrifice in voltage. Obviously even this cannot give us a total phase shift of 180°, but we can get it by using three "stages" of RC, each with a 60° shift, or four stages each giving 45°, and so on. Only very elementary a.c. theory is needed to calculate the phase shift and voltage reduction at any frequency due to one RC stage (as we have just done); but the total shift due to n equal stages is not n times that of one stage, nor is the total voltage ratio equal to the nth power of that of one stage. Connecting a second stage upsets the impedance of the first stage; and the third upsets both. The calculation of n stages is quite a difficult mathematical problem, but here is a table of the attenuation of 3 to 6 stages at the frequency at which the total phase shift is 180°:

Number of Stages n	Attenuation α
3	29.0
4	18.4
5	15.4
6	14.1

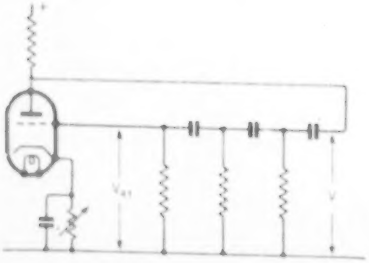
The figure $\alpha = 29$ for 3 stages means that the voltage across the final R or C is 1/29th of that put in across the first pair. So to obtain oscillation it is necessary for the voltage amplification of the valve to be 29 times. A 4-stage system allows a valve with a lower μ and higher power output to be used, if that is wanted. As we have seen, anything less than 3 stages is insufficient to give the required 180°; and the above table makes it seem (as is indeed the truth) that increasing the number of stages above 3 or 4 is unlikely to reduce the attenuation enough to be worth the extra components. Actually the amplifier input and output impedances generally introduce phase shifts that modify the above figures. Fig. 4 is a simple example of this type of oscillator.

Before going on, it may be as well to make sure that we are quite clear why such an oscillator oscillates at one frequency at a time, and why varying C or R varies that frequency. The answer, of course, is that there is only one frequency which makes the total phase shift through the RC "ladder" equal to the 180° necessary for bringing the oscillatory voltage at the grid into the correct phase to maintain itself. (To be strictly correct, other frequencies are possible, but only with an abnormally large number of RC stages, and in any case voltages at these frequencies are too heavily attenuated to cause oscillation.)

With the Fig. 4 type of circuit, in which the series elements are C and the shunt elements R, there is hardly any phase shift at very high frequencies, because the capacitances are almost short-circuits; and at very low frequencies the shift approaches 90° per stage. But whereas with a high-Q LC circuit the phase changes very rapidly indeed in the region of resonance (see Fig. 1), with the RC system the shift is spread gradually over the frequency range. In other words, it behaves in this respect like an LC circuit with very low Q. And whereas the amplitude falls off more or less steeply on both sides of an LC resonance peak, on one side of the working frequency of an RC system the amplitude actually increases. With the Fig. 4 arrangement, this is obviously the high-frequency side; but if the R's and C's were interchanged the slopes of both phase and amplitude graphs would be reversed. Fig. 5 shows the graphs for the Fig. 4 system, on the assumption that the

Fig. 3. Basic RC phase-shifting circuit.

Below: Fig. 4. How a 3-stage phase shifter can be connected to the single-valve amplifier to make it an oscillator. The variable cathode resistance acts as an oscillation control.



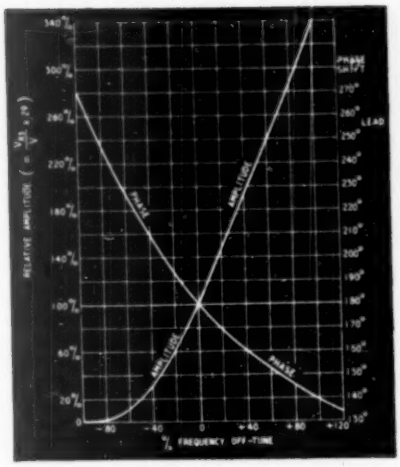
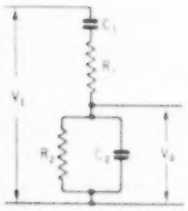
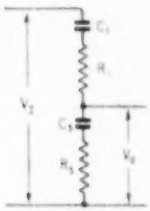


Fig. 5. Phase and amplitude graphs for 3-stage RC circuit as in Fig. 4, assuming negligible valve output impedance. When comparing with Fig. 1, note change of scale.





Left : Fig. 6. Series-parallel frequency-discriminating circuit for obtaining a phase shift of 0° or thereabouts at only one frequency.

Right : Fig. 7. At any one frequency, Fig. 6 is equivalent to this.

output impedance of the valve is negligible. The relative voltage figures (V_{R3}/V) have been multiplied by 29 (the correct valve amplification) so as to make the figure at the 180°-shift point equal to 1, or 100 per cent. Comparing Fig. 5 with Fig. 1 we see that for a given phase shift near the oscillation point the corresponding frequency shift is 200 times as great with the RC circuit as with a 100-Q LC circuit, so on this basis the RC circuit can be reckoned to have a "Q" of 0.5.

In short, the control of frequency by phase shift, with this type of RC circuit is very much less keen than that of any reasonable LC circuit, while its control by amplitude is entirely one-sided.

If two valves can be spared for the amplifier, then with the normal type of resistance coupling the output is in phase with the input, so the RC tuning circuit is relieved from the duty of creating a phase reversal. All it has to do is to satisfy the conditions for oscillation (in this case, to transmit the necessary amplitude with *no* phase shift) at the desired frequency, and fail as thoroughly as possible to satisfy them at all other frequencies.

There are various ways of arranging resistances and capacitances to achieve this, but the simplest is to have one of each in series and another of each in parallel, as in Fig. 6, where V_i means input voltage and V_o output voltage. It is going to be simplest to calculate, and satisfactory in practice, to make $R_1 = R_2$ and $C_1 = C_2$. Then it turns out that at the frequency which makes V_o in phase with V_i the reactance of C_1 (or C_2) is equal to the resistance R_1 (or R_2). It also turns out that the impedance of the $R_2 C_2$ pair is half that of $R_1 C_1$, so V_o is one-third of V_i.

One way of seeing how Fig. 6 functions is to compare it with Fig. 7. If we assume first that $R_3 = R_1$ and $C_3 = C_1$, then the impedance of the $R_3 C_3$ pair is in every respect the same as that of $R_1 C_1$. The current flowing through $R_1 C_1 R_3 C_3$ leads V_i by some angle between 0° and 90°, but the angle is the same for $R_3 C_3$ as for $R_1 C_1$. So obviously V_o is in phase with V_i and is half its magnitude. Now suppose R_3 is reduced to half R_1, and C_3 is doubled, so that its reactance is half that of C_1. The phase angle of the $R_3 C_3$ pair will be unchanged, but its impedance will be halved, so that V_o will now still be in phase with V_i but equal to only one-third of V_i in magnitude. Next, replace R_3 and C_3 by their parallel equivalents, given by the standard formulae :

$$R_p = \frac{R_s^2 + X_s^2}{R_s} \text{ and } X_p = \frac{R_s^2 + X_s^2}{X_s}$$

where the subscripts *p* and *s* indicate, as you have no doubt guessed, "parallel" and "series" respectively. If we assume that the frequency is such as to make X_s (which is the reactance of C_3) equal to the resistance R_s (which is R_3), then they become delightfully easy to work out : the results are $R_p = 2R_s$ and $X_p = 2X_s$. So, since $R_s = R_3 = R_1/2$, $R_p = R_1$ and is the same thing as R_2 ; and similarly X_p is equal to the reactance of C_2. We have therefore proved that when $R_1 = R_3$ and is equal in magnitude to the reactance of C_1 and of C_2, V_o is in phase with V_i and one-third its voltage. So if we make V_i the output of our 2-stage amplifier, V_o will supply the necessary input voltage, provided that the total voltage amplification is 3. That is not much to ask of a 2-stage amplifier ; in fact it will almost certainly be far less than the amplifier gives, so it will be necessary to lose most of the amplification somehow—a point we shall take up in a few moments.

In the meantime, note that if Fig. 6 were equivalent to Fig. 7 at all frequencies it would be unable to discriminate between one frequency and another, so that if the conditions for oscillation were satisfied at one frequency they would be at all frequencies. The object of connecting one RC pair in parallel is of course to introduce frequency-discrimination. If the frequency is raised, X_{C1} falls, R_1 becomes the dominating partner, and the current through $R_1 C_1$ comes more nearly into phase with the voltage across them. X_{C2} also falls, but that fact makes it dominate R_2, because the greater part of the current flows through it, and being 90° out of phase with V_o it widens the phase difference. So on both counts the phase of V_o departs from that of V_i. Similarly (but in the opposite direction) if the frequency is reduced.

It is also pretty clear that whether the frequency is increased or reduced it will reduce the magnitude of V_o relative to V_i. At zero frequency, the reactance of C_1 is infinitely large, so V_o is nil. At infinitely high frequency the reactance of C_2 is zero, so again V_o

is nil. In this respect Fig. 6 is closer than Fig. 4 to the LC circuit with its resonance peak. But it still has a very low "Q" compared with any reasonable LC circuit. This is shown in Fig. 8, which can be compared with Figs. 5 and 1.

An advantage of Fig. 6 is that there are two RC pairs instead of three or four, so a 2-gang capacitor (or rheostat) is sufficient as an effective variable frequency control.

Now the question of surplus amplification. What would happen if nothing were done about it? If the back-coupling of an LC oscillator is increased beyond the point at which oscillation starts, it makes the oscillation grow, and in so doing it drives the valve into heavy grid current or anode-bend cut-off, until its amplification is reduced sufficiently to restore the balance. In this process the oscillation is distorted. The same happens with an RC oscillator if the amplification is at first too great: the oscillation grows until the amplification is sufficiently reduced. But the distortion is very much worse, because in the LC oscillator the sine waveform is shaped mainly by the LC circuit itself, and is not very much dented even when the current through the valve consists of square waves or pulses. But the RC circuit lacks this flywheel or pendulum effect; if the amplification is increased even moderately beyond the necessary minimum the waveform goes all to pieces. That is why practical RC oscillators nearly always have an automatic device to keep them only just oscillating.

A 2-stage resistance-coupled amplifier of normal design is likely to have a voltage gain of several hundred times, even when no particular effort is exerted to make it large. In order to maintain good waveform this must be reduced to 3; but we can make a virtue of necessity, by using negative feedback for the purpose. This means applying such a large amount of back-coupling in the direction tending to stop oscillation that it is only at the very peak of the RC "resonance" curve that it is counteracted and oscillation is possible. The very flat RC peak and gradual phase curve can thus be geared up until they compare with those of a typical LC circuit.

Fig. 9(a) is the skeleton of a 2-stage amplifier. Positive feedback, to make it oscillate, can be introduced at one particular frequency by feeding one-third of the output back to the grid by means of Fig. 6. At the same time the large surplus gain of the amplifier can be neutralized at all frequencies by tapping off very nearly one-third of the output and feeding it back in opposite phase to the cathode. The complete circuit is then as in Fig. 9(b). Drawn like this, it can be seen in another light—as a Wien (pronounced "Veen") Bridge. A and B are the "generator" terminals, receiving the output from the amplifier; whilst C and D are the "detector" terminals, connected to the input of the amplifier. If the bridge is balanced (which can be done at only one frequency) there will obviously be no signal input and therefore no oscillation. Assuming, as we have done, that $R_1 = R_2$ and $C_1 = C_2$, perfect balance is obtained by making $R_3 = 2R_4$. Points C and D then both receive one-third of any output voltage there might be, in the same phase, so both are at the same potential. If R_3 is made less than $2R_4$, there is a net voltage between C and D, but in the opposite phase for maintaining output. If R_3 is greater than $2R_4$, there is a net voltage tending to maintain output, and if sufficient it will cause continuous oscillation. The greater the gain of the amplifier, the less the bridge has to be unbalanced to produce oscillation, and the easier it is to apply an automatic control to keep the system just oscillating and no more. The simplest method is to make R_3 a thermistor, as described in the August, 1949, issue, page 296.

Before superhets came into general use, the most-used method of obtaining r.f. selectivity was positive feedback ("reaction") just short of the oscillation point. In the same way this RC oscillator system, if set just short of oscillation, can be used for getting a f. selectivity. And that is the point where readers who want to pursue the subject farther can be handed over to J. McG. Sowerby (June, 1950, page 223).

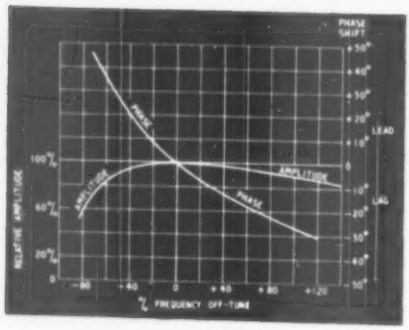
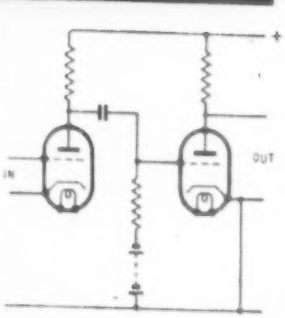
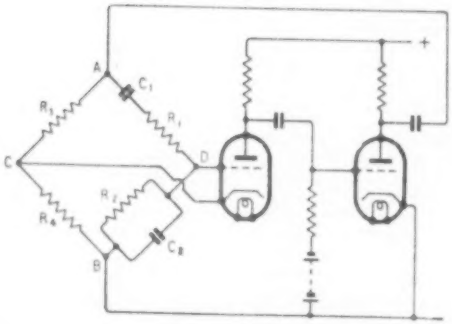


Fig. 8. Phase and amplitude graphs for Fig. 6 circuit, for comparison with Fig. 5.



(a)



(b)

Right: Fig. 9. (a) 2-stage amplifier alone, and (b) with output connected to input by Wien bridge circuit.

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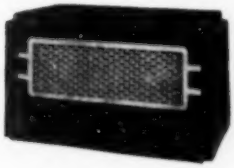

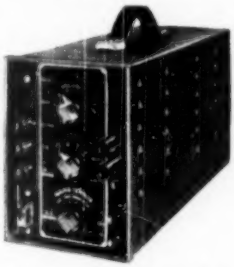

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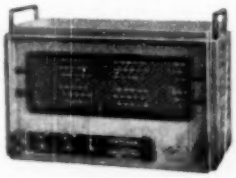

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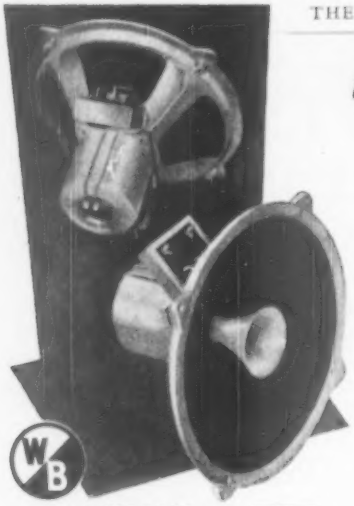

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The aerials at the M.C.A's. frequency checking station at Pailton. (*Photo: Courtesy Ministry of Civil Aviation.*)

THE photographs on this page show the imposing array of aerials and some of the precision measuring apparatus used at the M.C.A.'s frequency measuring station set up at Pailton, near Rugby.

Regular checking of the frequency and field strength of all airways navigational aids and communication sets, together with measuring the frequencies of all quartz crystal oscillators used in the various air and ground transmitters and receivers of civil airways, constitute the work of the station.

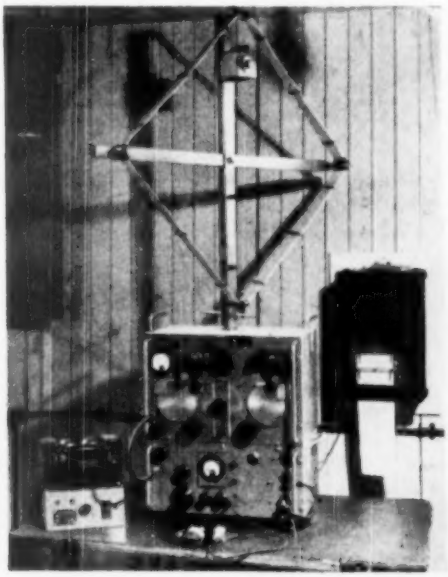
Pailton being roughly in the centre of England, most of the U.K. beacons, which operate in the 250- to 400-kc/s band, are received well enough for frequency and field strength measurement purposes. But the station has also some mobile equipment which makes on-the-spot measurements to supplement those taken at Pailton.

Records are kept of all routine measurements and a monthly graphical chart is prepared showing the day-to-day behaviour of all the navigational beacons. By international agreement these have to keep within ±0.05 per cent of their allotted frequencies. Checks are also made on all airport h.f. transmitters operating in the 3- to 11-Mc/s band.

Whilst the foregoing represents the principal activities at Pailton, numerous other tasks are also performed. For example, the frequency meters used by civil airways stations are periodically checked and re-calibrated if necessary and radio flight-tests are carried out with aircraft for the Ministry certificate of airworthiness.

Future plans envisage investigation into interference problems, measurement of harmonic and parasitic radiation from transmitters and a programme of work covering v.h.f. measurements.

Left: With this equipment regular measurements are made on beacons and ground transmitters used by civil airways. Right: The field strength measuring equipment used at Pailton. It is the Marconi Instruments type TME18 covering 150 kc/s to 25 Mc/s with interchangeable loops. (*Photos: Courtesy Ministry of Civil Aviation.*)



UNBIASED

By FREE GRID

Meteorology for the Million

SPEAKING as one of the "countless others" whom the Editor mentions in the July issue as being "more than usually dependent on sudden changes of weather," I cannot too warmly endorse his plea for the restoration of the discontinued "Airmet" meteorological broadcasting service and for its extension to cover the whole twenty-four hours of the day.

I have always made a point of carrying my umbrella, no matter how favourable the forecast; not because I lacked faith in it, but merely to safeguard my legal position lest at any time a "common informer," inspired by greed of gold, caused me to be arraigned before the Court on a charge of "aiding and abetting," since I have always understood that it is an offence against the law to "profess to tell the future." I am sure that, on paper at any rate, the learned scientist feeling his seaweed on the roof of the Air Ministry is equally guilty in this respect with Madame Estelle gazing into her crystal. If any of you who are

Further Outlook Unsettled.

learned in the law are of a different opinion perhaps you will quote chapter and verse to show me exactly when the law was altered to show discrimination between meteorological and matrimonial forecasts.

But while I whole-heartedly endorse the Editor's appeal for a 24-hour "Airmet" service, we part company when he lends support to a suggestion that the Third Programme channel should be employed during those hours of the day when it is normally not in use. To myself and other Third Programme listeners, among whom I am sorry to say it seems clear that the Editor is not numbered, such a sacrilege can only be compared to a suggestion that the nave of Canterbury Cathedral be employed as a dance hall at such times as it is not in use for ecclesiastical purposes.

To my mind the obvious solution of the difficulty would be to use the Light Programme channels by putting the words of the forecasts into the mouths of dance band crooners. These songsters (?) have but a limited vocabulary consisting of words like "blue" and "true" and "you," and no doubt they would be glad of something fresh to sing, such as "the north wind doth blow and we shall have snow." Dancers and others who enjoy these programmes would be only too glad if their favourite fare were to be continued throughout the 24 hours, and dance band leaders would be glad of the extra money.

Bob Allen Up to date

ENTERPRISE and initiative are qualities that have invariably appealed to me, and I am always pleased when I find outstanding instances of them in which radio plays a part. I was, therefore, agreeably surprised to see a television set in operation in the waiting room of a seaside doctor at whose surgery I called one evening in August to get something to ease the pain caused by a crab seizing my big toe when enjoying the delights of paddling.

The waiting room was crammed to the doors by patients, and it was obvious that most of them had only imaginary complaints and had come mainly to see the television programme, since the town was on a part of the coast well outside the nominal range of Alexandra Palace, and a television set in operation was a comparatively rare sight; indeed, it was only by the use of an elaborate aerial array and a super-sensitive pre-amplifier that it was possible to get and hold the programme.

At first I assumed that the only credit for enterprise was due to the dealer who had put in the installation and had affixed an artistic and yet conspicuous nameplate to it giving his name and address. I learned differently, however, when a fee was demanded of me for examining my toe, as I had expected to get it all free under the National Health Service as an emergency case, since I was well away from the area of my own doctor. Unfortunately, however, the seaside medico was not a member of the Service.

Subsequent enquiries laid bare the enterprising nature of this doctor, who had, without breaking any of Mr. Bevan's regulations or infringing any of the strict rules of professional etiquette about advertising, built up quite a lucrative practice. It was, in fact, fully up to the standard of permissible medical advertising set by Dickens' Bob Allen.

Enjoying the delights of paddling.

Autophone Service Wanted

CAR radio is now regarded as indispensable by all self-respecting motorists. In a few years it will be considered equally indispensable for a car to be on the telephone. Nobody, however, seems to be interested in the idea to-day, although it is technically possible by means of a micro-wave link to the nearest telephone exchange. Such a system is, in fact, in actual operation in certain "furrin parts."

It should be easy to stimulate interest in this country since, as is well known to people who matter, one of the big motoring organizations has in operation a radio patrol-car service whereby you can ring their H.Q. from the nearest telephone box and get a first-aid car directed by radio to your broken-down vehicle.

It would be quite easy to improve on this. Members of the organization could be provided with small fixed-frequency micro-wave transmitter-receivers to link up with a counterpart on the roof of the telephone kiosk which would connect the caller by landline to H.Q., without the necessity of getting out of his immobilised car and trudging wearily to the 'phone box. This roof-top link would be completely automatic in operation like the chain of stations between Sutton Coldfield and the Alexandra Palace. Once get motorists used to this and they would soon demand a fully fledged telephone service. Centimetre wavelengths and a chain of roadside pick-up stations would probably be necessary.

LETTERS TO THE EDITOR

The Editor does not necessarily endorse the opinions expressed by his correspondents

Spot Wobble

THE letter of H. S. Chadwick in your July issue queries a previous statement of E. G. O. Anderson in the May issue that "the light output is increased" by the use of spot wobble. If Mr. Anderson will permit, I would like to enter the fray on his behalf, and also because I find that the inability to appreciate that conditions of scanning and focus can affect the total light output is widespread. The following may help.

Given a fixed set of scanning conditions but always maintaining optimum focus there are two main considerations affecting brightness.

(1) Final anode voltage (affecting depth of electron penetration into the screen) will increase the light output progressively with voltage increase. The upper limit of brightness is a function of the screen thickness.

(2) Current increase affects brightness by putting more electrons on to the screen. The upper limit of brightness is when the individual electrons are so crowded that they fall only on screen material which is already excited to saturation by the previous electrons.

Now the light output from a screen as measured by a photo-cell and galvo does not increase in a direct ratio to an increase of beam current, due to the current saturation conditions of the screen.

As can be seen from the curve extracts below, doubling the beam current gives *less* than double the brightness. The higher the current the less efficient the screen becomes.

Beam Current (μA)	50	100	200	400
Brightness	0.6	1.1	1.9	3.15

But if in doubling the beam current the scanned area is also doubled then the brightness is maintained.

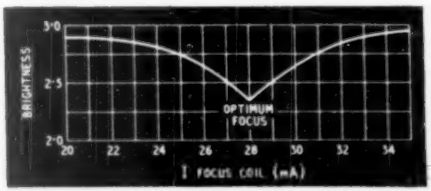
Now look at it another way.

If we scan the whole of the screen as in television practice, then about one-third of the screen (between the lines) is not being excited at all. The two-thirds of the screen being excited, is, for modern conditions of daylight viewing, working well up the current/brightness curve where the efficiency is reduced. If we now fill between the lines either by defocusing or by spot-wobble we reduce the current on the two-thirds previously bearing all the current, and we work on a more efficient part of the current/brightness curve.

The accompanying curve shows what can happen to brightness with changes of current through the focus coil, all other conditions remaining constant.

S. F. NUTKINS.

Hayes, Middx.



Record and Stylus Wear

I FEEL that Mr. Wood, in his article in the July issue, did not sufficiently bring out the main advantage of the cantilever pickup, namely, its ability to "iron out" the distortion due to pinch effect. I have myself recently constructed a pickup of this type with a moving-iron movement, and find that it is now possible to obtain excellent results from records which previously I considered virtually unplayable. Since many of these are of excellent musical quality it is satisfying to hear these performances unmarred by "pinchy" recording. Possibly this is the reason for the great vogue enjoyed by cantilever pickups in America.

My own experience as regards life of styli shows that a sapphire or ruby may be expected to play 150 sides in a 14-gm non-cantilever pickup, and 300 in a 7-gm cantilever pickup. This requires qualification, in that the records used were by no means all new; some, indeed, are still showing signs of the use of fibre needles in the "pre-sapphire era!" (It is significant that "fibre-wear" will, in the course of later playings with sapphires, gradually heal up, due to the burnishing action of the stylus.)

Using brand new discs only, these figures might be doubled; but most collectors have a large proportion of older discs, and the already-mentioned superiority of the cantilever types makes it probable that these will be played still more.

I also feel that Mr. Wood's curves, showing the deterioration of quality due to stylus wear, are misleading. The test discs used at present invariably start with the

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Operates on 12-volt battery or, by means of separate plug-in adaptor unit, on A.C. mains. Power output approximately 16 watts.

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AMPLIFIERS MICROPHONES LOUDSPEAKERS

highest frequency on the outside rim (groove velocity 47 in/sec). This highest-frequency band is shown as falling off by some 2½ db at 10 kc/s after 2,000 sides at 7½ gm, and 5 db at 10 kc/s, at 14½ gm. However, at the inner rim the groove velocity may fall as low as 15½ in/sec, and one may therefore expect a loss of 2½ (or 5) db at 3,500 c/s and correspondingly more at higher frequencies. In actual fact, a falling off in clarity towards the end of a side is just about audible after 200 sides, and becomes troublesome after 300; although these figures only represent averages, the behaviour of sapphires being decidedly unpredictable. Unless a very high degree of magnification is available, wear is audible long before it becomes visible.

S. C. HINE.

Harrow, Middx.

Nomenclature

FOR some considerable time now the words "capacitor" and "resistor" have been used to replace the original designations of "condenser" and "resistance." These designations I consider a great improvement. There is, however, another designation which I think is in need of alteration—"intermediate frequency." This should, in my opinion, be called "resultant frequency" or "resultant sub-frequency." It is not an intermediate frequency, but a sub- or lower-frequency created by the mixture of the signal frequency and the oscillator frequency.

F. B. RUDD.

Ormskirk, Lancs.

MAY I recommend to television manufacturers the discontinuance of the term "brightness control." "Brightness" on a knob tempts viewers to advance this control when contrast adjustment is actually needed.

The chief results are pictures which do a disservice to the television industry's future, and reduction of the life of the tube.

A change of name, plus improved instructions from some manufacturers on the use of their receiver controls, would go a long way to overcoming these troubles. Perhaps someone will complete the idea by suggesting a new word for the offending one.

W. P. ROWLEY.

East Molesey, Surrey.

Reducing Television Interference

THOSE who have to deal with complaints of interference radiated by the line time-base circuits of the modern television receiver might be interested to hear that some U.S. radio manufacturers make a practice of coating the inside of the cabinets with graphite in order to reduce this effect.

The mixture employed is a dispersion of colloidal graphite in water or other volatile base which is easily brushed or sprayed on glass, bakelite, wood or rubber as required. There are several variations of the mixture available which will form a fairly low-resistance skin and act as an electrostatic screen. In cases where an "uncoated" tube is used, the outer surface of the flared part of the glass envelope should also be coated in order to complete the screening in the forward direction, i.e., from the front of the receiver. Contact is made between chassis and "screens" by means of strips of aluminium foil attached by gum prior to the application of the graphite.

From observations made during tests carried out on a typical receiver after the application of a coating of Acheson's colloidal graphite ("dag"), it should prove possible to reduce unwanted radiations by at least ten times (20db). In applying this remedy to a.c./d.c. receivers, care must be taken to restrict the coating to the internal parts of the cabinet in order to eliminate the possibility of leakage paths to the live chassis.

G. T. CLACK.

London, S.W.12.

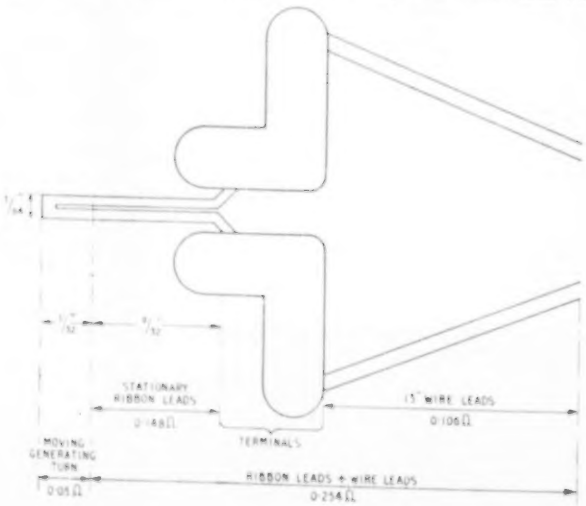
Pickup Design

MY letter in your July issue mentioned the mass of the moving parts of the single-turn pickup under consideration. A typing error converted the measured mass of 3.5 milligrams into the incorrect figure of 35 milligrams. I greatly regret the error, which many readers must have spotted, for it is widely known that single-turn pickups have been available for a considerable time where the moving parts have a mass of the order of 3 milligrams.

An objection has been made to my use of the word "new" to describe the pickup on which tests were made. The word was used to indicate that the pickup was in an unused condition. It was the latest model of which I had cognizance, and though I read the technical press thoroughly I have been unable to trace any announcement of a later model.

My statement regarding the proportions of resistance in a single generating turn and the leads has also been challenged. In confirmation of my statement I give a detailed drawing showing the relative resistance of the single generating turn, the remainder of the ribbon (ribbon leads), and the lead-out wires. The total resistance of the ribbon was measured as 0.198 ohm, the resistance of the moving part and the fixed part being calculated therefrom.

The drawing is approximately to scale, and it gives confirmation to my statement that the active signal-generating part of the ribbon is small compared with the rest of the loop formed by the remainder of the ribbon, the terminal connections and the leads running along the arm. This large non-signal-generating part of the loop is the main reason why



single-turn pickups tend to give higher hum/signal ratios than multi-turn generators. H. J. LEAK.

H. J. Leak and Company,
London, W.3.

American Insularity

I AM in entire agreement with Keith Henney (your July issue) that it is as a result of ignorance that the majority of American writers on technical subjects fail to give credit to foreign writers and inventors. In these circumstances, we must ask why this ignorance exists. The reason surely is that those writers who are aware of the facts do not all take the trouble to give credit, with the result that their readers are mis-informed, or not informed, as to the true situation. For example, Professor Maclaurin is in an exceptionally favourable position in that he writes from the Massachusetts Institute of Technology, whose library is obviously extremely well stocked and which, to my knowledge, contains many unpublished documents describing the work of foreign engineers. There is thus no excuse for his omission of this essential part of the story of the invention and development of ideas. Attention to details of this sort is a duty which an author must accept. The inclusion of these names is a courteous and pleasant way of acknowledging one's indebtedness to others both as an author and as one who has benefited by their work. It is interesting and instructive for the reader, and it rounds off a book which, without it, can cause much irritation to readers who know the true facts. O. S. PUCKLE.

Beaconsfield, Bucks.

MANUFACTURERS' LITERATURE

Marine radar activities described in a review (No. 5) issued by Cossor Radar, Ltd., Highbury Grove, London, N.5.

High-vacuum pumps and allied equipment described in a "digest" catalogue from W. Edwards & Co., Worsley Bridge Road, London, S.E.26.

Ex-Government Equipment List No. 7 (price 6d) from Clydesdale Supply Company, 2, Bridge Street, Glasgow, C.5.

Process timers described in List 120/B from Londex, Ltd., 207, Anerley Road, London, S.E.20.

Laboratory equipment, including resistors, capacitors and inductors, bridges, oscillators, magslips and servo components are covered in the latest series of bulletins from Muirhead & Co., Beckenham, Kent.

Hospital Patient-call system; details of the equipment in a leaflet from Ardente Acoustic Laboratories Ltd., Guildford, Surrey.

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RANDOM RADIATIONS

By "DIALLIST"

Preferred Valve Types

No one could agree more heartily than I with the suggestion made by James Franklin in the correspondence columns of last month's *W.W.* that we should adopt a small number of preferred types for valves. The saving to manufacturers of resistors brought about by the general acceptance some time ago of preferred values must be enormous. Not so many years have gone by since one could readily buy resistors marked, or colour-coded, 40,000, 45,000, 50,000 and 55,000 ohms. Comparatively few purchasers realized that there was a ±10 per cent tolerance in the values of standard grade resistors. But there was—and still is. Hence a resistor marked 45,000 ohms might have a true resistance of anything between 40,500 and 49,500 ohms; again, the genuine value of the resistor correctly marked 50,000 ohms could vary from 45,000 to 55,000 ohms. Except in certain precision circuits, such as those of the time-constant type, it does not greatly matter as a rule whether a resistor, specified by the designer as one of 50,000 ohms, has a real value as low as 50,000 − 10 per cent = 45,000 ohms or as high as 50,000 + 10 per cent = 55,000 ohms. Adopt a preferred value of 47,000 ohms and you assure the purchaser, if the tolerance is ±10 per cent, that the true value lies between 42,300 and 51,700 ohms; with a ±5 per cent tolerance it is between 44,650 and 49,350 ohms. The tolerances stipulated and accepted for valve characteristics are very much greater; it would seem, therefore, that the task of drawing up a short list of preferred valve types should not present any insuperable difficulties from this point of view.

The Price Question

Everyone with whom I discuss the subject (not excluding some big noises in valve manufacturing concerns in their calmer and more human moments!) is of opinion that the prices of "replacement" valves are too high; replacement valves being those that the experimenter or constructor buys over the counter for his work, and those bought in the same way by John Citizen to fill the gaps caused in his radio or television receiver by burn-outs, wear-outs or breakages. The style of both experimenter and would-be constructor is cramped. To my knowledge, the sales of radio receivers containing more than a modest number of valves—and still more so those of television sets necessarily sporting from 18 to 30—are restricted by the quite natural fear that some untoward happening involving his valves may land him in a position presenting two most disagreeable alternatives. Either he must spend on valve replacements an amount as great as, or even more than, the present value of his receiving apparatus, or he must be deprived of its services. One of the reasons given by valve manufacturers for the high prices charged for replacements is that they have to keep so many types on the market. The adoption of preferred types should help enormously here.

A Golden Opportunity

If ever the radio industry is to adopt preferred valve types, the present affords a golden opportunity. We're told (and I've no doubt about it myself) that the miniature valve will rapidly supersede the old "bottle." There are comparatively few types of miniature now being made and one kind of base is suitable for all of them. Were the problem energetically tackled *now*, it should be possible to guard against any runaway increase in the types of miniature valves like that which has occurred to the disadvantage of everyone, in those of the now more familiar size and shape. A firm foundation could be laid by agreement on the part of radio manufacturers to use only the B7G base for miniatures for, say, the next five years. Nor should it be unduly difficult to work out a range of preferred characteristics for a.c., a.c./d.c. and battery valves. Curiously enough, one of the biggest difficulties might be to agree on the preferred battery types, for with the coming of the "all-dry" radio receiver and of the mains/battery set this kind of valve has gained a new importance. The filament current has already been brought down to 50 mA and many of these valves will continue to function when the l.t. voltage has dropped to 1.1.

The Set of the Future?

It wouldn't surprise me if the broadcast receiving set of the near future was normally a universal affair, based on miniature battery valves. I see it incorporating lightweight dry h.t. and l.t. accumulators of types yet to be developed. In my vision of things to come both batteries are served by a.c. and d.c. trickle-chargers, the appropriate one being brought into action when required by a 3-position switch, marked "a.c.," "d.c." and "off." When the user has no mains supply, but can get his accumulators charged, he will have duplicate batteries, both with "plug-in" connectors and easily removed from, or inserted into, the cabinet. Should there be no charging station available, he will run his receiver from dry batteries of the inert type. These are already well known. They live fully up to their name, for they are genuinely dry when purchased and remain chemically and electrically inactive until water is supplied to their cells. The set owner who has either a.c. or d.c. supplies available will use just the opposite of the present mains set procedure. He will switch *off* the mains supply when he wants to use his set and switch it *on* when the programme comes to an end. In other words, the h.t. and l.t. accumulators will take charge of the receiver when it is in use and the a.c. or d.c. mains will take charge of the accumulators when it isn't. Fantastic? I don't think so. Remember, I'm thinking only of the domestic broadcast radio receiver. In the small living room of to-day—and probably to-morrow—no great output is required from the loudspeaker. The latter is, from one point of view, a most inefficient instrument, with a very low input/output ratio. Nor, again, does the compact, lightweight "dry" accumulator exist to-day. But I firmly believe that both the efficient loudspeaker and the small, light secondary battery with its electrolyte in semi-solid form are not too far away. Could these things be realized, as I am sure that they will one day, one single range of radio valves would fulfil the needs of the great majority of broadcast listeners.

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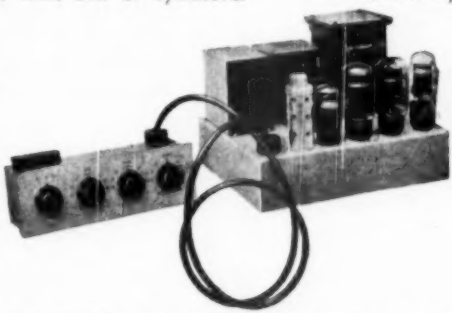

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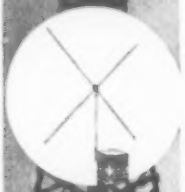

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Revolutionary in design and performance this aerial provides stronger signals and greater reduction of interference than the standard "H" array. Complete with 20' mast and chimney or wall mounting, or with pole mounting fitting.

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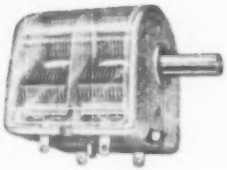

Miniature in Size, but big in performance. *The M.M. 2 Gang Condenser* has frame dimensions of only $1\frac{7}{16}$" x $1\frac{13}{32}$" x $1\frac{13}{16}$". Complete with dust cover. Cat. No. 4702.

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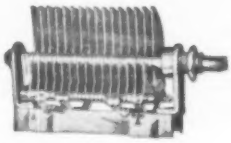

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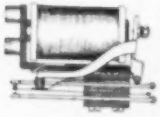
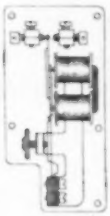


AMERICAN made with heavy duty contacts. Sensitive type which closes at approximately 4 m.A., **12/6.** Non-sensitive type for closing on 12-24v., **4/6.**



EXTRA light weight, extra sensitive for high speed or radio control work, weight only 1¼ oz., closes on 2 m.A., solid, platinum change-over contacts, adjustable pressure. Price **13/6.**

TOTALLY enclosed, in bakelite, this relay has a 24v. coil but can of course be re-wound for mains operation. Its contacts are suitable for breaking 20 amps. Price, **4/6, 48/-** doz.

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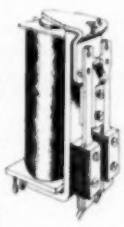
Low voltage types coil resistances of 100 ohms and over with 1 pr. of contacts, **3/6** extra contacts as above.



CONTACTOR for breaking 25 amps., coil voltage is 24v. D.C., but with a re-wind or a small rectifier these will close off A.C. mains. Very heavy duty solid silver contacts. Price **1/6**, **15/-** doz.

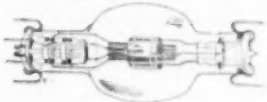
IMPULSE OPERATED RELAYS.

THIS is sometimes known as Selector Switch 10B. It consists of a solenoid, the armature of which is connected to a ratchet wheel so that each time the solenoid is energised the ratchet wheel moves round one notch. Secondary switches are built-in which permit: continuous running, inching, following a four position switch and undoubtedly a host of other operations. Articles have appeared in journals showing how these may be operated by radio impulses and thus control models. Price **3/9 each, 36/-** per dozen.

LIQUIDATOR'S STOCK

Polished walnut radio cabinet size 20 × 12 × 7½in. complete with L., M. and S. dial, size 7 × 6½in. and backplate with magic eye cutout, also with drilled chassis and hardboard back. You will find it quite a simple matter to complete this into a very handsome receiver of the £15 class. Limited quantity, price 32/6, plus 2/6 carriage for the 5 items.

TRANSMITTING VALVES.



THE valve illustrated is the VT31, a transmitting tetrode with an R.F. output of 250 watts. The overall size of this valve is 14½in. long by 6½in. across the bulb. We are able to offer this American made valve at 15/6, which is only a fraction of original cost. So this is your chance to do some experimenting or to make that special piece of equipment. Its heater is rated at 12v. 8a. We have many other transmitting valves in stock at equally interesting prices, we list a few below and invite your enquiries for any not listed :—

803 Tetrode 125 watts, htr. 10v. 5a., **10/-**
805 Triode 125 watts, htr. 10v. 3½a., **10/-**
813 Tetrode 100 watts, htr. 10v. 5a., **35/-**
DET5 Triode 25 watts, htr. 4v. 2a. **12/6**
RK28A. See 803 above.
TZ40 Triode 40 watts, htr. 7.5v. 2.5a., **27/6**
DET25 Triode 36 watts, htr. 6v. 1.25a., **15/-**
TZ05 20 Triode 40 watts, htr. 6v. 1.1a., **15/-**
807 Tetrode, 30 watts, htr. 6.3v. .9a., **5/6**
6L6 Tetrode 12.5 watts, htr. 6.3v. .9a., **8/9**
6J6 dbl. Triode 3.5 watts, htr. 6.3v. .45a., **10/6**
15T Triode 50 watts, htr. 5v. 4a., **25/-**.
PLEASE INQUIRE ABOUT OTHER TYPES.

RECTIFYING VALVES (MERCURY).

VU29 600 m.A. @ 4,000v., htr. 4v. 9a., **7/6**
866A 240 m.A. @ 10,000v., htr. 2.5v. 5a., **10/6**
872 1250 m.A. @ 10,000v., htr. 5v. 7.5a., **17/6**
RZ1 150 150 m.A. @ 1,000 v., htr. 4v. 4a., **15/-**
VU508 1,000 m.A. @ 8,000v., htr. 4v. 3a., **15/-**
GU21 3,500 m.A. @ 11,000v., htr. 4v. 11a., **45/-**.
OTHER TYPES WITH OUTPUTS UP TO 5 AMPS.

RECEIVING VALVES.

WE carry a full range of all types ancient and modern, send for special list, or if in a hurry ask us to send your valves C.O.D. We also stock Tungar Rectifiers, Voltage Regulators, Photo Cells, Magnetrons, Clystrons, Thyratrons, etc., etc. Send us your enquiries.

COMMUNICATIONS RECEIVER.

THIS is the communications receiver type No. R.1155 which is one of the finest communication sets ever made. Designed by leading engineers and made by one of our famous Companies, this receiver will undoubtedly give you years of good listening. Most readers will know it fairly well. The receiver covers the broadcast bands, long waves and medium waves, and short waves up to 20 mc/s. It contains 10 valves and really brings the stations in. August prices: **£6/10s.** for a good complete receiver; **£7/10s.** for same grade receiver tested and re-aligned; **£8/15s.** for unused receiver or **£9/15s.** for unused receiver tested and re-aligned. All plus partly returnable packing case deposit and carriage charge of 10/-.

SERVICE DATA.

100 service sheets, covering British receivers which have been sold in big quantities, and which every service engineer is ultimately bound to meet. The following makers are included: Aerodyne, Alba, Bush, Cossor, Ekco, Ever-Ready, Ferguson, Ferranti, G.E.C., H.M.V., Kolster Brandes, Lissen, McMichael, Marconi, Mullard, Murphy, Philco, Phillips, Pye, Ultra. Undoubtedly a mine of information invaluable to all who earn their living from radio servicing. Price **£1** for the complete folder.

OUR folder No. 2 consists of 100 data sheets covering most of the popular American T.R.F. and superhet receivers "all dry" etc., which have been imported into this Country. Names include Sparton, Emmerson, Edmiral, Crossley, R.C.A. Victor, etc. Each sheet gives circuit diagrams and component values, alignment procedure, etc., etc. Price for the folder of 100 sheets is **£1.** Post free.

PLUG AND SOCKET.

THIS brass cased plug and socket is extremely robust and ideal for P.A. or outside work. Ideal also for taking power to units as it insulates the ends of the wires. Contacts are quite suitable for carrying up to 10 amps. so this can be used for lighting or power. Price **2/6** per pair.

THIS MONTH'S SNIP

Lowest priced TV. parcel yet offered! This comprises an ex-Govt. unit which among a host of other parts contains 11 6.3v. valves and an excellent wide bandpass I.F. strip. With this we give without extra charge all the data showing how a really good TV. receiver can be made using this unit. Extra parts are needed of course but with the main unit at this low price the total cost should not exceed £10. Price for the unit complete with the 11 valves and the data is only 22/6, plus 2/6. Send today or you may miss this bargain.

Orders under £2 add 1/6, under £1 add 1/-. Postable items can be sent C.O.D. additional charge approx. 1/-. Good stock of all items at time of going to press. List **6d.** **Telephone: Ruislip 4780**

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Hallicrafter SX28 Communication Receiver. Perfect £37 10 0
BC348. Complete with all valves, converted for mains 200/250 A.C. New condition £15 0 0
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Point One Leak Amplifier, Leak crossover network, Leak pre-amp with tone control, Connoisseur single speed motor and Leak pickup. Fitted in oak cabinet, absolutely as new £52 10 0
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R1155, brand new in transit cases, air tested £7 15 0
Avo Meters, Model 7, as new ... £13 0 0
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Avo Mains Signal Generator, perfect £11 10 0
Taylor Meter, Model 90a, universal, as new £10 10 0
Decca Record Player, latest model, as new £8 0 0
Axiom 22, 12in. speaker by Goodmans, as new £8 0 0
Connoisseur Pickup, with transformer £2 15 6
National HRO Seniors, without coils or power pack, perfect order and condition £12 0 0
12v. Mobile Amplifiers, by Parmeko, complete with hand mike £11 0 0

WE NEED GOOD USED EQUIPMENT URGENTLY. PLEASE SEND, BRING OR PHONE FOR OFFER

Hunt's Resistance Capacity Bridge, model CRB, as new ... £10 10 0
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B.P.L. Signal Generator, model RS 600, as new £10 0 0
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INEXPENSIVE TELEVISION

is the title of the latest 48-page illustrated publication showing how a variety of ex-Govt. Radar Units can be converted readily and cheaply into efficient Television Receivers. Send only **2/9** for your copy, and a price list of the specified items.

RECEIVERS R.1355. As specified for above, complete with all valves. ONLY **55/-** (carriage, etc., 7/6).

R.F. UNITS TYPE 25. For use with R.1355 for London reception. ONLY **17/6** (postage 1/6).

R.F. UNITS TYPE 26 for use on Sutton Coldfield frequency are all sold, but we can supply one of the other R.F. Units with full details of modification, which has been fully tested some 70 miles from the transmitter. BRAND NEW IN CARTONS ONLY **25/-**; or slightly used **17/6** (postage on either, 1/6).

I.F. STRIP TYPE 194. Another of the units specified for Inexpensive Television. A first class strip giving tremendous amplification, and well recommended for constructors who have built a Televisor but have come "unstuck" in the vision or sound receiver. Contains six valves VR65, and one each VR53 and VR92. Size 18 x 5 x 5in. ONLY **45/-** (postage, etc., 2/6).

INDICATOR UNITS TYPE 6. As specified for above TV. Complete with valves and VCR97 C.R. Tube. BRAND NEW IN MAKER'S CRATES. ONLY **90/-** (carriage, etc., 7/6).

INDICATOR UNITS TYPE 62. Contains 16 valves VR65, 2 of EB34, 2 of EA50, and a VCR97 Tube. ONLY **75/-** (carriage, etc., 12/6).

TRANSFORMERS FOR "INEXPENSIVE TV" can be supplied as follows: Time Bases and Vision Transformer 350-0-350v. 160 m/a., 5v. 3 a., 6.3v. 6 a., 6.3v. 3 a., ONLY **36/-**. Sound Receiver Transformer 250-0-250v. 100 m/a., 5v. 3 a., 6.3v. 6 a., ONLY **27/6**. E.H.T. Transformer for VCR97 Tube, 2-0-2v. 1.1 a., 2-0-2v. 2 a., 2,500v. 5 m/a., ONLY **30/-**. POSTAGE 1/6 per transformer please.

MAGNIFYING LENS for 6in. Tube. First grade oil filled ONLY **25/-** (postage 1/6). Also available in 9in. size, ONLY **65/-** (postage, etc., 2/6).

TV PRE-AMPLIFIER for weak areas can be made with the minimum of conversion from the ex-R.A.F. Amplifier 6046/6050. A most efficient job. Supplied complete with 2 valves EF50 and full modification data for both stations. ONLY **22/6** (postage 1/-).

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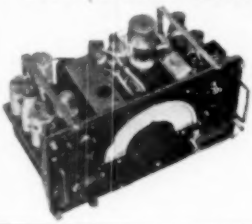

Probably the most widely used set in the world, operated by the active amateur and SWL alike. The R.1155, 7 valve communications superhet with an I.F. of 465 K.cs. and 5 wavebands. Covers "80," "40," and "20" metre bands, plus broadcast bands. Full vision dial, graduated in M.cs and K.cs. Requires only 200 v. H.T., 35 m.a. and 6.3 v. L.T. 1A.

CLYDESDALE'S PRICE ONLY £12 12 0 POST PAID

Complete with A.C. Mains Power Pack, mounted in a metal speaker cabinet and complete with 6V6 Output Stage. Connecting cables, and 8in. speaker.

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THAT "SHARP CHANNEL" Q5'ER

46129 (equivalent BC453) Command Receiver is quite effective and justifiably popular as a sharp channel I.F. system to follow any conventional communications receiver having an I.F. of 190 to 550 k.cs. The receiver operates with an I.F. of 85 k.cs. Except for rewiring the heater circuit (24 volts as is) to conform with the supply available, no further major modifications need to be done. The BC453 makes an excellent car radio for M.W. reception, and can be readily modified by installing the M.W. COIL UNIT, price 10/-, from us, and correcting the valve heater circuit to conform with supply available, and installing a speaker and H.T. Vibropack.

CLYDESDALE'S PRICE ONLY 63/- CARRIAGE PAID

Circuit diagram supplied with each unit.

R.F. 27 UNITS.

These 1st Class converter units cover a frequency of 65 to 80 Mc/s with variable tuning over the entire range. This converter has an oscillator tuned to an output of approx. 7 Mc/s which can be fed into practically any Receiver which tunes the "40" metre band. Valves include VR136 EF54 (R.F.), VR136 EF54 (Mixer) and VR137 ECS2 (Oscillator). Requires only 6.3 v. 9A. L.T. and 300 v. 20 m.a. H.T.

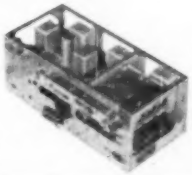
CLYDESDALE'S PRICE ONLY 35/- POST PAID

NOT ON MAINS SUPPLY !

The R1224 provides the answer to that. This is a 5 valve battery driven communications receiver employing one R.F. stage and a 465 Kc/s I.F.—with excellent selectivity and sensitivity. Frequency coverage is 1 to 9 Mc/s (300 to 33.3M) in three switched wavebands. Tuning is effected by a slow motion drive. Requires only a 120 v. H.T. battery, a 2 v. accumulator and a G.B. Enclosed in wooden cabinet.

CLYDESDALE'S PRICE ONLY £5 19 6 POST PAID

WHY MISS THAT DX ON 2-METRES



BC-624 (SCR-522) Receiver chassis provides the basis for the new 2 metre receiver. A coverage of 100 to 156 mc/s covers the "144" band. Spot frequencies may be "Locked" by using the local oscillator as it is at present or modifications to this stage provides variable tuning. 12 mc/s I.F. stages.

Complete with all valves, including 1.9002, 3.9003 B7G Based types.

Requires only 300 v. D.C. HT at 75 m.a. and 28 v. L.T. (valves can be rewired for 12 v. heater supply).

FREE, BC-625 Transmitter chassis, partly disembled, but including a host of VHF components, including 2 valve bases for 832 829 tubes FREE.

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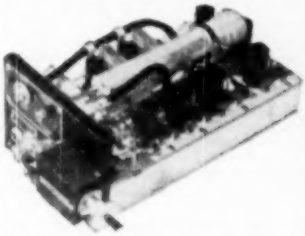
CALLING CQ 70 CENTIMETRES



The A.S.B.B will provide the receiver with which to hear those 70 cm. calls.

This is a 12 valve double superhet originally designed for use on 515 M/cs. Simple modifications and re-tuning will bring this receiver onto 420 M/cs. Employing a 446A Lighthouse Triode as the R.F. stage, the following stages include:

955	1 st. Oscillator—460 M/cs.
955	Mixer.
2.6AC7	1 st. and 2 cd. I.F., 55 M/cs.
6J5	2 cd. Oscillator, 39 M/cs difference.
6AC7	2 cd. Mixer.
2.6AC7	1 st. and 2 cd. I.F., 16 M/cs.
6H6	Diode Detector.
6AC7	Video Amplifier.
6AC7	Cathode Follower.

Details can be supplied for modifications to the last three stages to provide A.N.L., "S" Meter and Audio Stages, tuning instructions and constructional details for A.C. Mains Power Pack.

Unit Dimensions: 11¾ x 5½ x 7½in.

CLYDESDALE'S PRICE ONLY £4 10 0 each POST PAID

A.C. Mains Power Unit with Built-in Modulator

for W.S 36 Transmitter. Cat. No. H.43

A complete 110 to 250 volt cycle A.C. Mains Power Unit, consisting of one L.T. supply transformer—4 v. 4A. (3 windings) for the rectifier, etc., at 3.25-0-3.25 v. 6A. winding supplying the 6.3 v. circuit of a built-in modulator, suitable for swinging a transmitter carrier of 100W. input, plus an outlet for the supply of an external transmitter. A 200-0-200 v. 50 m.a. fully smoothed supply for bias needs a second transformer (H.T.) 500-0-500 v. 200 m.a. (twice) rectified and smoothed, one supply for the internal modulator, the second supply is carried to an outlet for external use.

Valves include 3.6C5, 2.807 and 2.AV1 (FW4/500). Controls are located on the steel front panel. Unit complete in varnished wooden cabinet with carrying handles.

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APOLOGIES

We apologise for an error which occurred in the details given for our Output transformer type 2836 in the Williamson Amplifier booklet. There is a choice of seven output impedances by series parallel connection. These are:— 1.25, 2.8, 5, 7.8, 11.3, 15.3 and 20 ohms.

This incidentally is the component that has aroused so much interest in the U.S.A.

By the way, there is now an improved version type 2836B leakage reactance under 15m/hys. Primary inductance is still 100 hys minimum, price 90/-.

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Full constructional data in book form now available—it comprises what is in our opinion the most practical, economical and reliable method for the construction—by the amateur—of a full-size magnetic televisor.

The instructions given are detailed, precise and remarkably easy to follow. Both theoretical and practical (point-to-point) wiring diagrams are given. Our technical experts have carefully examined the circuit and are most enthusiastic ; we can find no inherent snags of a practical nature which are likely to occur.

The "EASYBUILT" is particularly suited for the home constructor as the designers have taken exceptional care to specify only those components which are readily available at reasonable prices. IN FACT THE TOTAL COST (LESS C.R. TUBE) SHOULD BE WELL UNDER £20. We are making a special point of stocking all the specified parts for the "EASYBUILT," and will have a demonstration model on view early in September. As usual, our prices are extremely competitive.

ORDER YOUR COPY OF THE "EASYBUILT" TELEVISOR MANUAL NOW. THE PRICE IS ONLY 2/6 POST FREE.

We shall include with each copy a priced parts list. All components will be separately listed and available individually. Don't forget that those of you who buy the major portion of your gear from us will be given every assistance during AND after construction. London and Home Counties viewers will be able to bring the completed televisor to us for service and alignment should this prove necessary.

3 NEW RELEASES—3 OUTSTANDING BARGAINS.

Amplifier Unit Type 3562. Brand-new in cartons. Complete in case size 12 x 9 x 8in. Valve line-up : one of 5U4, two of 807, one of EF50 and an EA50 ; many high-voltage condensers and resistors included. Easily converted to a high-output amplifier or modulator unit. The useful chassis lends itself to amplifier construction, etc., **19/6**, plus 3/- carr. and pkg. Don't miss this superb offer.

Receiver Type R1147B. A 7-valve UHF receiver, range approx. 200 Mc/s. PARTICULARLY SUITABLE FOR EASY CONVERSION TO 144 Mc/s. Valve line-up : two of EF50, 2 of EF36, and one each of EBC33, RL7, RL16. The receiver is beautifully constructed and fitted with micro-condenser drive. Contained in black metal case size 8 x 7 x 6in. BRAND-NEW IN USEFUL TRANSIT CASE which might have been designed as a tool box ! ONLY **30/-**, carriage paid.

Receiver Unit Type 6A. Housed in case size 10 x 8 x 7ins. Frequency range 3-7 Mcs. Valve line-up : 5 of EF50 and one each EBC33, EF36, and 6K8. The dial is exceptionally well geared and calibrated. Slightly soiled condition externally but perfect inside. **29/6**, plus 2/6 carr. and pkg.

STILL GOING STRONG.

Medium-wave Command Receiver. Frequency range 200-600 metres. Valve line-up : three of 12SK7, one of 12SR7, one of 12K8 and a 12A6—all miniature types. Will readily convert into a car radio or domestic receiver of outstanding performance. Unused and in excellent condition. We provide circuit diagrams. **£3/19/6**, plus 2/6 carr. and pkg.

Receiver Unit 25/73 (TR1196). Valve line-up : two of EF36, two of EF39, one of EK32 and an EBC33. Easily and rapidly converted to a very fine superhet receiver (see "Practical Wireless" August, 1949). Supplied complete with circuit and conversion data. In very good condition indeed and offered at **22/6**, post free.

Receiver Type 18. Complete with four battery valves. Frequency range 6-9 Mc/s. Circuit diagram provided. **17/6**, plus 1/- post and pkg.

45 Mc/s. "Pye" Strips. New. Less valves, **39/6** ; complete with all valves **62/6**, carriage paid.

Indicator Unit Type 62A. Contains 12 EF50, four of SP61 (CV118), two of EB34, three of EA50, 13 pots and one VCR97 tube. This is the finest Indicator Unit of them all. Unused condition, but chassis slightly soiled. Offered to callers only. Price **£4/19/6**.

Amplifier Unit 10/165. A neat and compact equipment incorporating the following valves : two of EF36, one of EBC33, and two EL32 ; and microphone transformers, inter-valve transformers, numerous condensers and resistances, etc. Are you looking for something to "break down" ? Then here is your chance ! An experimenter's gold-mine for only **17/6**, post paid.

Have you visited our easily accessible London premises ? A treasure house for the enthusiast. Come along and see ! A very competent technical staff always at your service. Huge stocks of valves, components and TV/Radio equipment at attractive prices. Many, many bargains for the caller.

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STANDARD PANEL MOUNTING RACKS. Type 10A/9591. Height 5.5ft. For 19in. panels. Drilled every inch. Supplied with panels total 3ft., which carry terminal strips, etc. Suitable for transmitters, amplifiers, commercial eqpt., **£2** each.

DIEHL LOW INERTIA A.C. SERVO MOTORS. CDA 211052. New, **17/6**.

RADAR EQUIPMENT AND COMPONENTS. Type SA2 Transmitter Receivers. 10 cm. Employs 2/22 Magnetron, 721A ATR, 726B Klystron, etc. Type SA2 Antenna Duplexers, SO No. 12283. Type SA2 Servo Control Units CNM-55ALB1. Type APN9935. Cavity Tuning Units. Westinghouse Model VE Type CAY-55ADV Plan Position Indicator Repeaters. Electronic Range Marking, 7in. tube presentation. General Electric Model VG Type CG-55AEB Projection Plan Position Indicator Repeaters. Electronic Range Marking, 24in. screen presentation. Type TS-13 AP "X" 3 cm. Blind Radar Test Sets. Western Type CW60-ABM Wavemeters "S" 10 cm. Band for use with SLI Radar, etc. Type R54 APR4 Radar Receivers, 300-1000 Mc/s. R.C.A. Type CRV-46ACG "S" Blind Radar Receiver Indicators. Type CRV-50AEE Deflection Amplifiers. Type SA2 Modulator-PPI Indicators. Type APS3-MD-5B Radar Modulators. Type APS3 Antenna Scanning Units. Type CMMSS-ABL1 Slewing Train Indicator. Reflector Klystrons Type 723A/B 75/-. Radar Gas Gaps Type 1B24, **15/-**, 721A, **15/-**, 724B with cavity holder, **15/-**. Valves Type 715B, **35/-**. Waveguides "H" 1 cm. Blind Launching Sections, **35/-**. "X" 3 cm. Band Launching Sections, **25/-**. "S" 10 cm. Launching Sections, **35/-**. 1 cm. 90 deg. Angle, **10/-**. 3 cm. Receiver Section, with 723A/B Holders, mounted in unit with I.F. Amplifier stages, **15/-**. 3 cm. Section 90 deg. bend, 90 deg. twist, length 14in., **15/-**. Rotating Joint, 3 cm., **45/-**. 3 cm. Antenna Radiator Section, **25/-**. Details of the above available on request.

NEW AMERICAN AUTO-DRYAIRE Model 2200 DEHYDRATORS. For the conditioning of coaxial transmission lines and waveguides. Designed for continuous operation with totally automatic cycle governed by programme timer. With 100 per cent. relative humidity intake, an output of 860 c/c. in. per min. at nil per cent. maximum relative humidity is obtainable, with a maximum pressure of 40lb. per sq. in. For 115-230 v. A.C. operation, 640 watts, **£45**. Also Portable Model with similar performance, **£27**.

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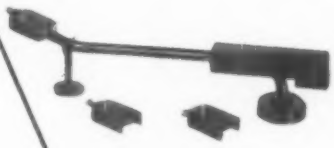

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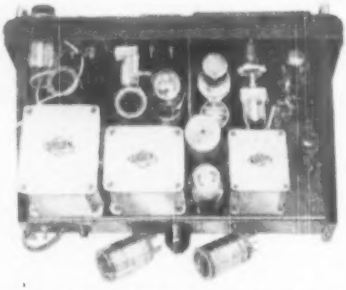

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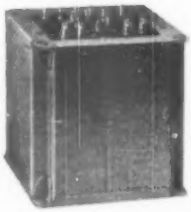

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All connections are via a small circular terminating strip on rear of coil unit. This can be placed over frequency changer, giving shortest possible circuit leads.

Coil Pack in carton with instructions. Pre-aligned. Post Free. **19/6**

Ranges covered: 16 to 50 metres and 200 to 500 metres.

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FULL VISION DIAL ASSEMBLY

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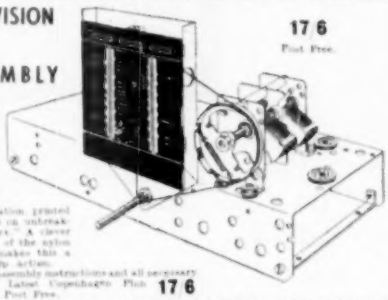

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A.	W.B. Chassis, tube supports, speaker, valveholders, etc.	£2	8/2
B.	T.C.C. condensers LONDON	£2	9/1
C.	T.C.C. condensers MIDLAND	£2	9/6
D.	Westinghouse Rectifiers	£1	4/6
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G.	Set of valves	£2 2 2	7/10
H.	9 inch Tube, including tax	£3 9/-	15/-
I.	Mullard 12 inch Tube, incl. tax	£4 12 6	£1
J.	Ferranti or Brimar tube, including tax	£4 12 6	£1 1/-

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Head of torch 3½in. in diameter.
Torch is 10½in. long.
Torch fully guaranteed.

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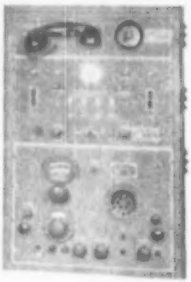

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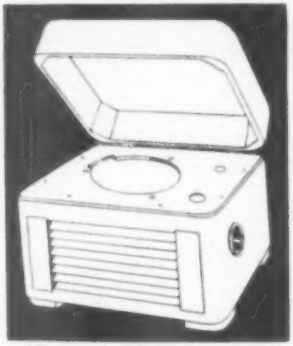

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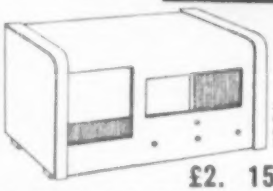

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Size	with trans.	less trans.
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5in.	12/6	—
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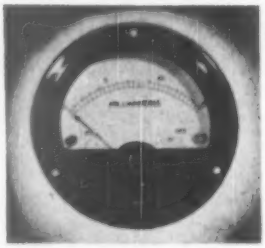

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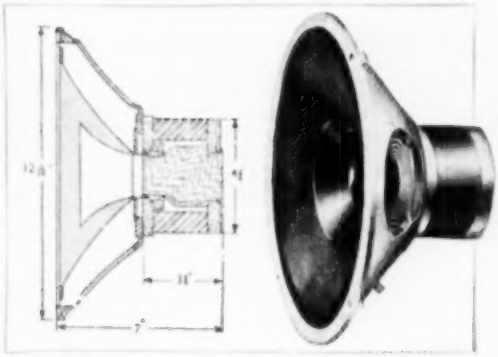

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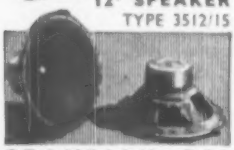

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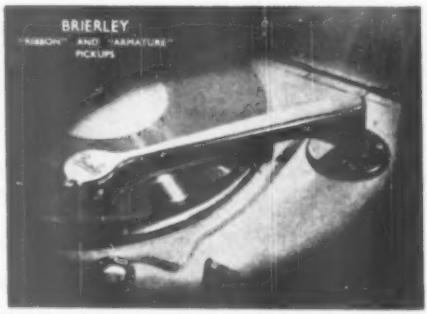

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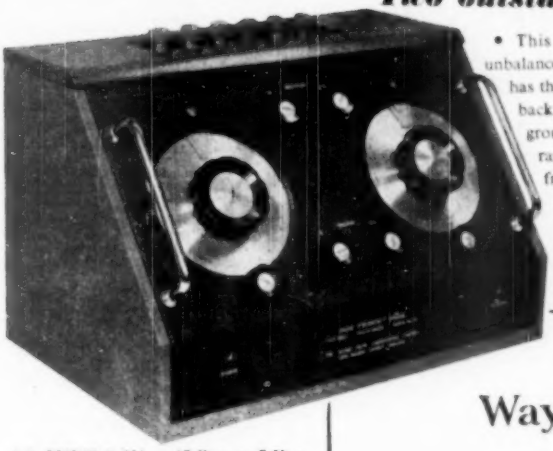

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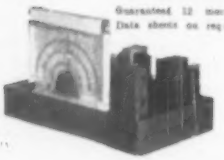

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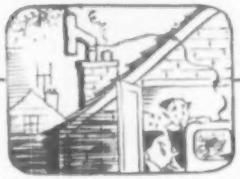

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Readers are warned that Government surplus components which may be offered for sale through our columns carry no manufacturers' guarantee. Many of these components will have been designed for special purposes making them unsuitable for civilian use, or may have deteriorated as a result of the conditions under which they have been stored. We cannot undertake to deal with any complaints regarding any such components purchased.

NEW RECEIVERS AND AMPLIFIERS

RADIO amplifiers for schools, hotels, clubs, etc., from £18.18.—AIRCTRON 4-station superhet feeder units, £7/7, with valves, agents required in all areas.—AIRCTRON RADIO Co., Peel St., Chadderton, Lancs. [5745

UNIVERSAL ELECTRONIC PRODUCTS, 56, Marylebone High St., London, W.1. Welbeck 4055.—SPECIALISTS in the design and manufacture of high fidelity reproducing equipment from 5-100 watts for domestic or industrial purposes. Our new twin channel amplifier (type U.E.57) with independent bass and treble outputs, provides the most satisfying standard of reproduction we have yet experienced. It is now being demonstrated in our showrooms daily (we close Thursday 1 p.m., Saturday 4.30 p.m.), and we invite those who seek perfection from recorded music to hear this superb instrument. We also offer tuning units or complete chassis designed and constructed to individual requirements. [10126

HALLICRAFTERS dual diversity receivers, complete with power units and loudspeakers, few only available.—M. ELROY ADAMS MFG. GROUP, Ltd. (Hallicrafters), 46, Greyhound Rd., London, W.6.

12-watt high quality amplifiers, bass and treble boost, £12.10, lists.—Broadcast & Acoustic Equipment Co., Ltd., Tombland, Norwich. [10065

BERNARDS, makers of television, radio, and amplifier equipment, available for early delivery, television time-base chassis and E.H.T. supply combined, 5 valves, completely wired, tested, only new components used, £7.12.8.—BERNARDS, 12, Chelverton Rd., Putney, London, S.W.15. Put. 7559. [10097

CHARLES AMPLIFIERS, Ltd., are now able to produce amplifiers, radio units and electronic equipment to specification; enquiries invited for development work and for short production runs.—Charles Amplifiers, Ltd., 40, Kenley Rd., S.W.19. [0173

THE Spencer-West type AC/4 convertor unit permits reception of the Birmingham transmitter when employing a London type receiver; specification includes 5 valves, self-contained power unit and new pre-amplifier; full particulars available on request.—SPENCER-WEST, Quay Works, Gt. Yarmouth. [5654

THE Spencer-West type AC/5 television pre-amplifier will give a performance superior in every way, but in particular superior so far as "snow" is concerned; provision is made for connection to all types of commercial receivers; available for trial if desired; leaflet, etc., available on request.—SPENCER-WEST, Quay Works, Gt. Yarmouth. [5655

BROUGHTON quality amplifiers, 10-12watts, for 5, 9, 15ohm speakers, p.p. output, couples to pre-amp by extension cable for a full range of bass and treble control, complete with top cover; £26.10, packing crate £1.5 returnable, carriage paid.—C. Steward, The Glen, Broughton Rd., Hadleigh, Essex. [5799

NEW amplifier by Midland Radio Coil Products. The Symphonic Seven High Fidelity portable, seven watts of high fidelity reproduction in highly portable form, full bass and treble tone controls, 2-stage N.F.B., high gain, price £10.15.6.—For full details of this and other amplifiers and radio feeders address a post card to 19, Newcomen Rd., Wellingborough. [5618

BUY direct from manufacturers, our radio-gram chassis are truly remarkable value. 5-valve all-wave superhet, large fully illuminated glass dial, complete with valves and speaker, aerial, tested ready for installation, price £12 inclusive, carriage paid; 2d stamp for illustrated leaflets; trade enquiries invited.—Bayly Bros., 46, Pavilion Drive, Leigh-on-Sea, Essex. [5575

J.R. ELECTRICAL & ELECTRONIC DEVELOPMENT, Ltd., Hubert Rd., Birmingham, 6 (Aston Cross 3440), the Midlands specialist manufacturers of high fidelity sound reproduction equipment, for the world-famous Williamson amplifier and associated accessories including tube control stages, loudspeaker crossover units, distortionless contrast expanders and radio feeders; send for details and prices. [5479

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TELRAD ELECTRONICS, 70, Church Rd., Upper Norwood, London, S.E.19.—Designers and manufacturers of Telrad quality amplifiers; established as the most outstanding value in high-quality amplifiers; thanks to faithful reproduction at unrivalled price, these unique amplifiers are the first choice of the enthusiast, built to satisfy the discriminating ear, bass and treble independent controls, providing widest possible variation to suit all recordings and varying acoustic properties of one room with another; £18 complete; full details on request.—Write, call or 'phone Livingstone 4879. [10019

TECHNICALLY far ahead of any other reproducer is the Williamson amplifier; a satisfied customer says: "After searching for 5 months and listening to many other so-called quality amplifiers, I have at last found what I want. The R.T.M.C. version of the Williamson is the finest product of the kind, and workmanship and parts used are unsurpassed. This goes for quality of reproduction, too." We have many other letters in similar strain. There is no doubt the Williamson amplifier will satisfy the most critical music enthusiast. It is the ultimate choice if you want trouble-free reproduction with super quality. Price £23.10, 7-valve mode, £28.10, 9-valve mode (with built-in pre-amplifier). See previous adverts. Also "W.W." booklet on this famous amplifier. We are open all day Saturday for demonstrations. Send for details (please 4½d stamp) to R.T.M.C. (Ealing), Ltd., Lauriel House, 141, Little Ealing Lane, W.5 (Ealing 6062). [10159

RECEIVERS, AMPLIFIERS—SURPLUS AND SECOND-HAND

H.R.O. Senior, speaker, 6 coils, power pack.—Offers to Box 5904. [5789

SX28, an immaculate model, in perfect showroom order, £100.—Box 5800. [5780

EDDYSTONE 680, as new, makers guarantee expires December, 1950; offers.—Box 5795. [5766

R1155 receiver, power pack speaker, in neat cabinet; new condition, perfect order; phones, £10; London.—Box 5862. [5821

8-VALVE a.c./d.c. radiogram, chassis, 5 w.b., illuminated glass dial, 10 watt P.P. output, perfect condition, £12.12.—Box 6116. [5841

MURPHY radiogram A15BR in perfect condition, £70; seen by appointment.—Ashley, 111, Heath Villas, Vale of Health, N.W.3. [5850

INEXPENSIVE television, two R1355, two RF26, VCR97, power packs, assembled; offers.—Swinburne, 1, Doric Ave., Frodsham, Cheshire. [5758

HALLICRAFTER S-41W, tuning 500kc-30mc, bandspread, B.F.O., separate speaker, 250volt a.c./d.c., price £14.—Lewens, Kennels House, Kintbury, Newbury, Berks. [5788

COMMUNICATIONS receivers.—H.R.O. Senior, Rx's, in good condition, complete from £12.10, plus carr.; also AR77, AR88, CR100, etc.—State requirements to R.T. & I. Service, 238, Grove Green Rd., London, E.11. [10055

WILLIAMSON amplifier with pre-amp (2 inputs), T.V. sound, O.P. meter (with bias and h.t. ranges, etc.), switched O.P. for 6L6's as beam tet.'s, basis of t.r.f. with inf. imped. detector, £25 or nearest offer to Ollington, 4, Glebe Hyrst, Sanderstead, Sy. [5765

WILLIAMSON amplifier, Goodman Axiom 12in. Collaro mixed autochange, fitted coil pick-up head, pre-amplifier with bass, treble and middle lift, radiogram cabinet, all virtually new; nearest £60 the lot; reason for sale, matrimony.—Vennard, Coombe Ridge, Bourne Lane, Brimscombe, Glos. [5786

HALLICRAFTER (U.S.A.) SX28, 15-valve communication receiver for sale, world-wide reception, television sound, gram input, twatts high fidelity push-pull output, privately purchased (not ex-W.D.), in perfect unsolled mint condition; details on request and offers considered.—K. Blackwell, 41, Meadway, Old Southgate, London, N.14. [5762

HAMMERLUND Super-Pro for sale, new in 1941 and little used, in perfect order and complete with universal mains unit and loudspeaker, 540kc/s to 30mc/s continuous coverage; offers wanted, also HC540 R receiver, as new and unused and not converted, purchased 2 years ago and never used; offers wanted.—Bryan Groom, 2, Gordon Terrace, Edinburgh, 9. [5817

NEW DYNAMOS, MOTORS, ETC.

BATTERY chargers, 4 models 2-6-12v. 1-2-4 amp D.C.; any mains voltage, also larger types; special transformers, chokes, test gear, Interior car heaters, etc.—The Banner Electric Co., Ltd., Hoddesdon, Herts. [0122

COMPLETE L.P. RECORD SERVICE

Our 18 months' experience of solving the problems associated with L.P. records here and in the U.S.A. is now crystallised into a comprehensive service for you.

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COLLARO STANDARD MICRO GRAMS, new in original cartons, £13 10/-. Case with motor-board only, 47/6.

BASS REFLEX CABINET, 2ft. 6in. high x 1ft. 2in. wide x 10in. deep for 8in. speaker, superb acoustic results. Complete kit of timber, etc., with instructions, 75/-, ready built, 85/-, carriage 5/-.

FULL BARGAIN CATALOGUE 2½d. **DEMONSTRATIONS DAILY.** Terms c.w.o. or c.o.d.

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JANETTE d.c. to a.c. rotary converters, 200/250 volts d.c. input, 200/250 volts 50 cycles single a.c. output at 500 watts new £105, 300 watts, £25, complete with smoothing for television and radio.—Johnson's 519, Kensington High Rd., London, S.W.11. Reliance 1412-3. (0000)

ALL types of rotating electrical machinery up to 30kva available, including rotary converters, rotary transformers, motors, petrol and diesel-engined generating plants, alternators and d.c. generators. We are also in a position to quote for power transformers, as actual manufacturers we will be glad to quote for any quantity for home or export.

DIESEL Electric generating plants, 5kva, 230v with push-button remote control, starting equipment, ready for use, £195.

ROTARY transformers, input 20v d.c., outputs 230v d.c. and 300v d.c., permanent magnet field, 20/- ditto, input 28v d.c. and 1,200v, 70ma d.c. output, energised field, 35/-; ditto, input 12v d.c., output 300v, 90ma d.c. energised field, £5.

PETROL electric generator plants, comprising a J.A.P. No. 2a single cyl. engine coupled by vee rope drive to an alternator giving an output of 250v 50 cycles, 600 watts, with screened ignition and filtering on generator, eminently suitable for operating television and radio on farms, etc., price £85, such plants can be supplied with various outputs, a.c. or d.c., for other applications.

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DYNAMOS, MOTORS, ETC. SURPLUS AND SECONDHAND

ENGINE-driven 1 stroke air cooled, foot started alternator 250 1/50 watt and 7.5v. 10a d.c. self energised, a.c. voltage automatic regulation, mounted on light portable frame, another exactly similar and serviced by makers, E.D.C.C., £25, delivered and tested; 12 and 24v lighting plants, petrol or T.V.O. 10/5 per gallon, petrol engines, 6v 72, 85, 120 and 200 watts.—W. World "July, page 74, also August; no lists; please state exact requirements; see displayed advt. page 76, for ATC rectifiers.

PEARCE, 66, Great Peter St., London, W.C.1.

NEW LOUDSPEAKERS

BASS Reflex cabinets, beautiful walnut finish, for all good speakers, stamp leaflets.—Cabinetware, 14, Heyes St., Blackburn. (0090)

LOUDSPEAKERS SURPLUS AND SECONDHAND

AXIOM 22, makers carton, £9 pressure unit, 2 No. 215, Hazel Rd., Huyton, Lancs.

BARKER, 14in. brand new £9/10.—Raymond, 106, London Rd., Slough, Bucks.

LOWTHER-VOIGT PM1 unit, PW1 corner reflector speaker in mahogany and whistle pipe, £50.—Box 5755. (5756)

VOIGT domestic corner horn, white, as new, unmarked twin diaphragm unit and power pack, £55.—48 Swanage Rd., S.W.18. (5757)

WHARFEDALE W.15/C.S. unused, £9/10. Box G.12, mains, £5/10; Garrard 202a motor and turntable, £2/10 little used. Singer, 3, Industrial Haves Road. (5753)

GOODMANS 12in. P.M. speaker, standard model, 70/-, also Goodmans Axiom 12in twin cone, 30/-, both as new and in china; carriage paid.—Howell, 14, Market Hill, St. Ives, Huntingdonshire. (5758)

COMPLETE Lowther Voigt equipment, including two Voigt speakers, L.P. units in corner horns, tuner, amplifier, M.C. P.U. rectifier units, filters, etc., to Lowther, Decca and Lexington, plus gram. motor and selection quality rosewoods, all as new.—15, St. Augustine's Av., Margate. (5807)

TRANSMITTING EQUIPMENT

TR9 transmitter-receivers, these were formerly sold at £6 each, the remaining few to be cleared at 25/- carriage paid.—THE STAMFORD RADIO Co., 149, Stamford St., Ashton-under-Lyne, Lancs. (5770)

HALLICRAFTER transmitters, Type HT43 (Hickok), complete to makers' latest specification, covering all frequencies from 1mc to 30mc, complete with speech amplifier, microphone, cables, etc., limited quantities only now available.

PANORAMIC adaptor, Type MCA44, British made, suitable fitment to any good-class communication receiver, in addition to all Hallicrafter models, immediate delivery.

HALLICRAFTER official sole agents in U.K. (including services and spares).

MULLOY ADAMS MFG. GROUP, Ltd., 46, Greybound Rd., London, W.6. Tel. Fulham 1802. Cables, Hallicraft, London. (5212)

NEW TEST EQUIPMENT

AVAILABLE from stocks, new cathode ray beam switch unit, 6 valves, self-contained power pack, variable switching frequency, provisional price £10/13/6, enables two separate traces to be displayed on one cathode ray tube.—FERNANDS, 72, Chelverton Rd., Putney, London, S.W.15. Put. 7530. (0098)

LABORATORY test equipment.—Signal generators, oscilloscopes, freq. meters valve voltmeters, valve testers, output meters, megohmmeters, etc., by Marconi, Ferris, Cossor, Cossor Ultra Taylor, etc., not available. Please state requirements.—R.T. & I. Service, 274, Grove Green Rd., London, E.11. Ley. 4464. (5252)

OSCILLOSCOPE and Wobbulator complete, £28. T.R.C. 5in. 650 D.C. c.r. X and Y plate amplifiers, easy to handle, has outstanding performance, fully guaranteed, immediate delivery with set of leads and booklet.—Oscilloscope Technique, further details from the manufacturers, Erskine Laboratories, Ltd., Scale by-the-Sea, Norwich. (0190)

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OSCILLATOR UNIT. Constructed on small chassis suitable for sub-assembly, provides r.f. for erase and bias at 45 kc/s. Requires 250v. h.t. and 6.3v. for operation. Complete with 6V6 valve, £3/-/-.

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RECORD REPRODUCE HEAD. High or low impedance. High quality response. Totally enclosed. Gap length 1 mil. £2 2/-.

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TAPE. New high coercive force tape suitable for high fidelity recording at slow speeds. 7in. (1,200ft.) reels. £1 10/-.

11in. (1,000 metre) reels also available.

RECORDING and reproducing amplifiers, desks, and complete machines available shortly.

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TEST EQUIPMENT—SURPLUS AND SECONDHAND

AVO model 7, £14.—Hill, 81, West End Ave., Harrogate. [5816

AVO 7 £12. Aso signal generator £8, little used, as new.—Box 5754. [5755

AVO valve tester and Phillips test bridge, as new, best offer.—139, Goldhurst Terrace, N.W.6. Mal 6135. [5840

E.M.I. type CO101 oscilloscope and V.Vm. £40 only or two bought £35.—Bartholomew, Chapel by Kirkcaldy, Fifeshire. [5779

TAYLOR 65B sig. gen., as new, £10. Taylor 45a valve tester, perfect, £11.10. Davenset garage charger £7.10.—50, Mile Oak Rd., Southwick, Sussex. [5765

OSCILLOSCOPE. Taylor Model 50A, almost unused. 5in tube, 1.8. and amp. max. sensitivity 60 mv per cm. guaranteed, £19.10.—nearest offer.—Crosfield, 45, Craigland Rd., N.W.1. [5646

METERS, all 2½in dials, 0-2,000 electrostatic, 0-20, 0-1 amp moving coil, 0-2, 0-2 amp thermo, 5/-; 5mA thermo, rectifier, £1.11; 6.2 volt, 3 amp, M.E.S. bulbs, 4/6 dozen.—Passingham, 95, North St., Keighley. [0092

AUTOMATIC voltage regulators for a.c. mains Ferranti, 7.5kva., in wing coil, frequency compensated, undistorted output waveform, tapped to suit any nominal supply between 200 and 250v. 1ph. 45 to 66cps (input voltage may vary from 86% to 106% of nominal output 100% v.a.), complete with voltmeter, spares, handbook, brand new, in original oiled paper wrappers and esp. ft packing cases. Govt. surplus, offered at a fraction of normal cost, overseas enquiries invited.—P. R. Crawshay, 166, Pixmore Way, Letchworth, Herts. [5156

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UNUSED valves, 615 50/-, 652 10/-, 805 50/-, 845 30/-, 337 7/6, T2 40 15/-, 1625 5/-, 1208 2/6, also 2.4kv 35ma mains transformer, 50/-, post extra.—Harris, 10, Kingsley Av., W.13. [5861

NEW GRAMOPHONE AND SOUND EQUIPMENT

MAGNETIC tape, Emitape type 65 on 1,200ft 7" spools, 25/-; paper tape, 25/-; blank recording discs, 7in d. shell, 4/6; all from stock. Trade terms available.—SOUND DISCS (SUPPLIES), Ltd., 178, Brighton Rd., Southport, Lancs. Tel. 6155. [5835

INFINITE baffle corner deflectors, scientifically designed acoustic chambers for 8 to 15in speakers, insts.—Broadcast & Acoustic Equipment Co., Ltd., Tombland, Norwich. [0064

TRANSFORMERS, tone control and loudspeaker filter chokes for all "W.W." circuits, special designs promptly made.—R. Clarke, 50, Langland Crescent, S. Stanmore, Middx. Wor. 5521. [5976

TAPE recorders amplifier can be used independently, 4.5v. portable amplifiers, complete with speaker and crystal microphone, p.p. output, in leatherette carrying case, £20; sound and electrical equipment, p.o.—A. Clark, 112, Carbonside St., Glasgow. [5848

TAPE recording panels, a precision panel, comprising two motors, high fidelity sound and erase head, high speed capstan of unique design giving tape speeds of 7½in and 15in per sec., suspended between walls with heavy fly wheel to ensure freedom from wow, no unlacing of tape is necessary for rewind, panel finished in black crackle, size 14in×12in, £30.

HIGH fidelity tape heads as fitted on our panels, record-playback, £4.10; erase heads, £4.10; standard record playback, £1.10; erase head, £1.10; osc. coil, 15/-; head to grid transformers, 7/6. Circuits supplied with orders, trade inquiries invited.

MORECAMBE SOUND SERVICE, Healand Works, Cross Con. Morecambe. Tel. Heysham 30. [0078

GRAMOPHONE AND SOUND EQUIPMENT—SURPLUS AND SECONDHAND

RECORDING wire, stainless steel, .006in dia. 5,600ft reels 5/6.—16, Catherine Rd., Levenshulme, Manchester. [5728

PORTABLE M.S.S. disc recorder, excellent condition, £27 or best offer; details.—Tel. Forest Hill 8862, Box 5705. [5751

WINCHESTER-CHICAGO portable recorder, one hour spools, nearest £60, hardly used.—Dr. Badham, Bodiers Park Hospital, Chertsey, Surrey. [5800

M.S.S. recorder, amplifier, mike, stand, monitor and phones, all transportable, seldom used, cost £190, offers to Wordsworth, 8013, or would hire. [5755

MAGNETIC sound recording wire, stainless steel, temporary wooden spools, approx. 1½ hours' running time at 2ft per sec., 14/- per spool.—A. Smart, 40, Grange Rd., Halewood, Liverpool. Phone: Tarbet 19 (tele. cabinet).

1 Portable, 13 watt, in tele. cabinet, 2 moving coil microphones, complete with floor stands and 1 hanger stand, complete in wood case, 1 portable playing desk (electric) complete with pick-up in case, 2 Goodmans loud speakers, 12in, suitable for social club or similar organisation, £50 the lot; can be inspected.—Apply, M.E.M. Co., Ltd., Reddings Lane, Birmingham, 11. [5776

NEW COMPONENTS

CRYSTAL microphone inserts (Cosmocord Mic-6), guaranteed brand new, 15/6, post free.

RADIO-AID Ltd., 29, Market St., Watford. Tel. Watford 7668. [0036

YOU are bound to try an Osmor "Q" Coil—pack eventually and be delighted with the results, why not save time and money now? Send a stamp for free circuits and latest lists of coils, condensers, dials, etc., etc.—OSMOR RADIO PRODUCTS, Ltd. (Dept. W.C.A.), Borough Hill, Croydon, Surrey. Tel. Croydon 1220. [0046

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Potentiometers. New Centralab: 2K, 5K, 10K, 25K, 50K, 100K, ½, 1, 2 and 3 meg., one switch, 3/9, with switch 6/-. Midget Type 2/6. Midget with switch, ½, 1 and 1 meg. 5/-.

Coils. Denco Maxi "Q." High "Q" with miniature size Litz wound on Polystyrene Formers with adjustable Iron Dust Cores. Aerial, H.F., or Oscillator for 465 k/c or 1.6 m/c. Range covers all wavebands from 8.8 to 2,000 metres. Wiring Diagram. **Prices:** Chassis Mounting, 3/9 (with React. 4/9). Metal fitting pin base, 4/- (with React. 5/-).

Denco T.R.F. Matched pair Medium and Long Waves, 6/6 pair. Waymouth T.R.F. Matched pair M. and L. Waves, 9/6 pair. Superhet Matched pair S. M. and L. Waves, 8/9 or 11/6 pair. All types Wearite "P" Coils, 3/- each in stock. Wymouth Midget 1¼in. × 1 dia., Iron Core, Aerial H.F. or Osc., 3/6 each.

Electrolytic Condensers. R.E.C. Midget tubular: 8 mfd. 450 v. (1¼in. × ⅝in.), 2/6; 8+8 mfd. 450 v. (1¼in. × 1in.), 4/-; 16+8 mfd. 450 v. (1¼in. × 1in.), 4/6; 32 mfd. 350 v., 5/-; 16+16 mfd. 450 v. (1¼in. × 1¼in.), 4/6; Dubilier "Duplex" Cartridge Tubular, 4 mfd. 500 v., 3/6; 8 mfd. 500 v., 4/-; 16 mfd. 500 v., 4/6; B.I. Cartridge standard size, 8 mfd. 500 v., 3/9; 8+8 mfd. 500 v., 5/-; 16 mfd. 350 v., 4/3; 16+16 mfd. 350 v., 5/3; 32 mfd. 350 v., 5/-. All New Stock.

Denco I.F. Lines for superhetes using 465 k/c or 1.6 m/c I.F. channels. Pre-tuned circuits, battery operated and completely self-contained. Price 42/- (incl. P.T.).

Osmor Midget Coil Pack. Size 3¼in. × 2¼in. × 1¼in. covering S. M. and L. Waves. Coils wound on Polystyrene Formers with adjustable Iron Cores, ensures efficient performance. Factory wired and aligned. Price, including full circuits for superhet 465 k/c. Unit, 33/-. Also available for T.R.F. circuit covering M. and L. Waves, 20/-.

Output Transformer—Siero's. Midget 1¼in. × ⅞in. × ⅞in., ratio 60:1, 3/6; ratio 40:1, 3/6; Mono Multiratio (over 12 ratios, some C.T.), 3/9 watts, 7/6. Siero's Heavy Duty Multiratio, all C.T. Tapped handles 10 watts and suits P.X.4s, 6L6s, etc., 25/6. Rola Multiratio, 3/9 watts, 10/6.

L.F. Chokes. Midget 10 henry 100 ohm, 40 m.A., 3/6; 20 henry 200 ohm 60 m.A., 5/6; 20 henry 300 ohm 100 m.A., 10/6; 10 henry 300 ohm 150 m.A., 18/6; 10 henry 500 ohm 150 m.A., 18/6; 8 henry 500 ohm 300 m.A., 8/6.

Aluminium Chassis. Substantially made of gauge 16 S.W.G. with four sides. 7in. × 4in. × 1½in., 3/3; 9in. × 5in. × 1½in., 4/-; 10in. × 5in. × 2½in., 4/11; 10in. × 8in. × 2½in., 5/6; 12in. × 8in. × 2½in., 6/8; 14in. × 9in. × 2½in., 6/11; 16in. × 8in. × 3½in., 7/3; 16in. × 5in. × 3½in., 8/6.

I.F. Transformer, 465 k/c. New well-known manufacturer's surplus 2in. × 1¼in. × 1¼in. Iron Core, 9/- each. Denco Iron Core, 465 k/c, or 1.6 m/c, 1¼in. × 1¼in. × 3½in., 16/6 pair. Wearite Stand Cap. Tuned, 465 k/c, 20/- pr.

Meter Rectifiers. Westinghouse 250 m.a. or less, 11/6. 1 m.A., 10/6. 2 m.A., 4/9.

Selenium Rectifiers. H.T. L. Waves: 60 m.A., 5/-; 100 v., 100 m.A., 5/9; 120 v., 100 m.A., 7/6. Bridge Rectifier 12 v. 1½amp., 12/6; 12 v. 2 amp., 19/6; 12 v. 3 amp., 25/-; 24 v. 2 amp., 23/6; 6 v. ½ amp., 7/6.

Charger Transformers. Each has input of 200 volts. Output(s): (3) 4 volts tapped 15 v., 5/6; 4 v. at 2 amps., 21/6; (2) 30 volts tapped 15 v. and 8 v. at 2 amps., 22/-; (2) 30 volts tapped 8 v. at 1 amp., 14/3; (4) 15 volts, ½ amp., 11/3; (6) 15 volts tapped 8 v. at 1 amp., 19/9; 15 volts tapped 8 v. at ½ amp., 11/9.

Valve Heater Auto Transformer. Step-up or down, 3 v., 4 v., 5 v., 6 v. or 7 amp., 9/6.

Filament Transformer. Inputs 230 volts, outputs 4.5 v. ½ amp., 7/6; 4 v. ½ amp., 7/6; Input 200/250 v., output 4 v. (C.T.) ½ amp., 4 v. 2 amp., 6.3 v. 2 amp., 19/6.

Denco Chassis Cutter. Adjustable between 2½in. and 3½in. dia., used with Hand Brace, 7/6.

"MAINS or BATTERY PERSONAL KIT"

A complete KIT OF PARTS to build our new MIDGET 4-VALVE SUPERHET PERSONAL SET, covering MEDIUM and LONG WAVES and designed for MAINS or BATTERY operation is now available.

This 2 Waveband Superhet Receiver is designed to operate on A.C. mains 200/240 volts, or by an "All-Dry" Battery, either method being selected by means of a Rotary Switch. It is so designed that the Mains Section (size 9¼in. × 4¼in. × 3¼in.) is supplied as a separate Kit, which may be added at any time. The kit therefore can be completed either as an "All-Dry" Battery Personal Set, or as a Midget Receiver for Combined Battery Mains operation.

The circuit incorporates Delayed A.V.C. and Pseudodyne Audio Feedback. A Rola 6in. P.M. Speaker with generous size Output Transformer ensures excellent quality reproduction. Ready Wound Frame Aerial. Fully aligned I.F. Transformers, and a Dubilier Midget Chassis are included. Valve line up:—I.R.5 (F.C.), I.T.4 (I.F. Amp.), I.A.5 (Diode Det and Audio Amp) and I.B.4 (Output Pet).

The set is quite easily built from the very detailed assembly instructions supplied, which includes a practical component layout, with point to point wiring, and a circuit diagram for both the Set and the Mains Unit.

Price of COMPLETE KIT (less Mains Unit), £6 13 9. Price of COMPLETE MAINS UNIT KIT, £1 17 6.

EVER READY Type B114 BATTERY, 9/7.

An attractive Walnut Finished Cabinet (size 9in. × 9¼in. × 4¼in.) to the blueprint 3d type and suitable to house the complete set is available for 19/9.

THE COMPLETE ASSEMBLY INSTRUCTIONS mentioned above can be supplied separately for 1/9.

A Midget T.R.F. Battery Portable "Personal" Kit. A complete Kit of Parts to build a Midget 4-valve All-dry Battery Personal Set. Consists of Regenerative T.R.F. Circuit employing Flat Tuned Frame Aerial, with Denco Iron Dust Cored Coil, thereby ensuring maximum gain for Single-Tuned Stage covering Medium Waveband.

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Price for Complete Kit, £3 18 9 (plus 16/7 P.T.). Suitable specialised Cabinet (9¼in. × 6¼in. × 7in.), 12/9. Ever Ready B114 Battery, 9/7. Building Instructions, Circuit, etc., supplied separately, 1/-.

A Complete Kit of Parts to build a **Midget "All Dry" Battery Eliminator**, giving approx. 75 volts H.T. and 1.4 volts L.T. This Eliminator is suitable for any Personal Set requiring H.T. and L.T. voltages indicated above. The Kit is quite easily and quickly assembled and is housed in a Light Aluminium Case, size 4¼in. × 3¼in. × 3¼in. It can therefore be accommodated inside most makes of Personal Sets. **Price of Complete Kit £1 17 6.**

"Wireless World" Midget A.C. Mains 2-Valve Receiver. We can supply all the components, including valves and M.Coil Speaker to build this set as specified in the March issue at a total cost of £3. Reprint of detailed assembly instructions and circuit supplied separately for 9d.

"Wireless World" Midget A.C. Mains 3-Valve Receiver, covering Long and Medium Wavebands. We can supply all the Components, including Drilled Chassis, Valves, Moving Coil Speaker, etc., to build this set, as specified in the Feb. issue, at a total cost of £4 5 - including a reprint of the complete Assembly Instructions and Circuit (this is available separately for 9d.).

An attractive **Walnut Finished Cabinet** is now available for this W. World 3-Valve Set at 21/-, or it can be supplied with a complete Dial and Drive Assembly which includes the latest Station Name Dial and Dial Escutcheon, and a Combined Switch Volume Control to effect very slight modification. Inclusive price, 25/- (Dial and Drive Assembly with Switch V. Control supplied separately for 14/-).

We can supply all the Components, including Valves, M.Coil Speaker, etc., **to build a Midget A.C. D.C. Mains T.R.F. 3-Valve plus Metal Rectifier Receiver** as designed and specified by a popular Technical Magazine, at a total cost of £4 17 6. A reprint of the assembly instructions, and layout available for 9d.

An Entirely Complete 3-Valve Amplifier Kit of Parts. Operating on A.C. or D.C. Mains 200/250 volts. Has an output of max. 4 watts, with valve line-up 2A5, 5U4 and U31. A 6½in. Moving Coil Speaker is supplied. Price, including Wiring Diagram, 75/- (or less M.Coil speaker, 65/-).

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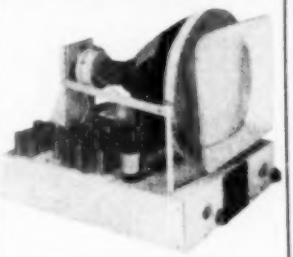

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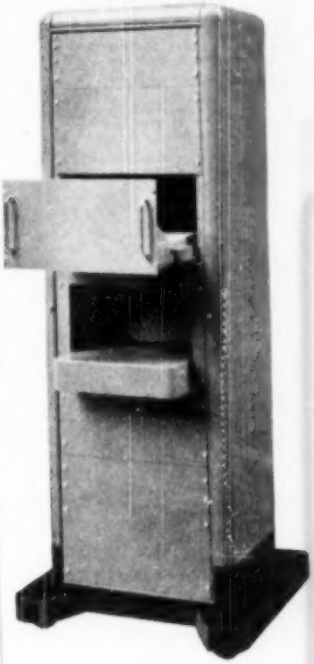

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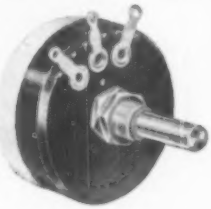

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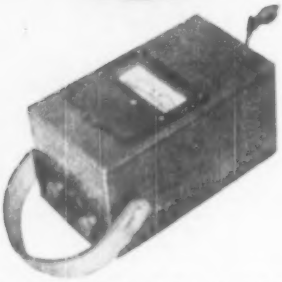

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ESTIMATOR required, accustomed to working on own initiative on production radio equipment; only experienced men need apply. S.W. London area.—Box 5238. (5666

EXPERIENCED television service engineers required immediately North West London district, five-day week, good salary and prospects to suitable men.—Box 5075. (5626

AMALGAMATED WIRELESS (AUSTRALASIA) Ltd., invite applications for positions in its Research Laboratories and Works, Sydney, Australia, in the following categories:—

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(3) RADIO engineers, City and Guilds standard or equivalent, with about 5 years' experience in the development and preparation of prototype models for the production of electronic equipment.

(4) VALVE production engineers with 3 to 5 years' experience in the production of (a) receiving valves and (b) power valves; this type of work will be in connection with the overall manufacturing phases in one or other of these categories.

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GRADUATE engineers required for high-frequency cable testing.—Apply, giving age, experience and salary required, to Ref. 424, Siemens Brothers & Co., Ltd., Woolwich, S.E.18.

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APPLY, giving full particulars, to Manager, Electronic Engineering Dept., The British Thomson-Houston Co., Ltd., Rugby. (5679

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MINISTRY OF SUPPLY invites applications from Physicists and Electronic Engineers for unestablished appointments in the Experimental Officer class at Research and Development establishments in and near London.

Minimum qualification Higher Schools Certificate, applicants also invited from candidates holding Higher National Certificate in light electrical engineering, including electronics, or higher qualifications; experience in the following fields is desirable: electronic measurements in connection with field trials, radio and electronic circuitry, high-speed electrical transients, electronic development, general experimental research requiring some mathematical facility. SALARY according to age, qualifications, experience, etc., within ranges: Experimental Officer (minimum age 28), £505-£675 (London), £485-£645 (Provincial). Assistant Experimental Officer, £325-£470 (London), £320-£460 (Provincial). Rates for women somewhat lower. APPLICATION forms obtainable from Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, W.C.2, quoting A214/50A. Closing date, September 14, 1950. (5701)

INTERNATIONAL company require radio mechanic and/or fitter, for around Syria over-seas. Single candidates preferred with City & Guilds Certificates and experience airfield installations, initiative essential approximately £375 to £450, free quarters, pensions fund.—Write, Box 5700.

E. K. COLE, Ltd., have vacancies for testers at their Electronics Division, experience in the testing of radar, communications or electronic equipments to Ministry specifications essential.—Full details in writing to the Personnel Manager, Malmesbury, Wilts. (5600)

RADIO testers for Midlands, Midland manufacturers require men with experience of radio gear to train as television testers, good rates of pay and opportunities for advancement.—Write, stating age and experience, to the Personnel Manager, Box 5601. (5792)

RADIO and television testers and trouble shooters required by large manufacturer in East London area, applicants should have previous experience with a manufacturer and adequate technical knowledge.—Please state age and full details of experience to Box 6119. (5855)

MINISTRY OF SUPPLY invites applications from Physicists and Electrical Engineers for the following unestablished appointments in the grade of Principal Scientific Officer: (1) at London Headquarters, 2 & 3; at the Royal Aircraft Establishment, Farnborough, Hants.

1. PHYSICIST or Electrical Engineer for co-ordination, guidance, and control of research and development in one of the following fields: (a) Radio components, development of new components for new radio equipments and assessment of fundamental requirements to meet the equipment needs. (b) Radio navigation and radar development and research to meet operational requirements for radio and radar navigation devices, aircraft approach and landing aids. (c) Radio communications, development and research to meet operational requirements for communication systems (airborne and associated ground equipment), special test equipment, etc.

3. PHYSICIST for work on radar display, digital and analogue computers, and radio and line communications equipment.

5. PHYSICIST for research and development in connection with electronic valves and cathode ray tubes. Candidates should be at least 31, and possess a good honours degree in physics or electrical engineering, with considerable experience including research, in the appropriate field of work. Salary assessed on age, qualifications and experience within ranges £950-£1,250 (London), £910-£1,177 (Provincial). Rates for women somewhat lower. Posts carry F.S.E.U. benefits. Application forms obtainable from Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, W.C.2, quoting A 215/50A. Closing date 14 September, 1950. (5700)

ELECTRICAL engineer required for technical duties in Australia with a firm of repute in manufacturers, general experience in the manufacture of capacitors or research on dielectrics is desirable; good prospects for suitable applicant.—Reply, giving all pertinent information, to Box 5610. (5613)

RADIO RENTALS, Ltd., expanding business needs for permanent engineers and television engineers in London area and Southern Counties; ownership of saloon car essential, excellent prospects.—Apply by letter only in the first instance to Service Manager, 55/61, Wentworth Grove, London, W.2. (5697)

ELECTRONIC test engineer required, primarily for tests and experimental work on development projects and special products; salary £350-£500 p.a. according to ability and experience.—Apply in writing to All-Power Transformers, Ltd. (Instrument Department), Chertsey Road, Byfleet, Surrey. (5546)

CHIEF engineer required to take charge of small laboratory at radio manufacturers in N.E. London; must have good technical ability in design of R.F. test equipment and radio components; write, giving full particulars of qualifications and experience, stating age and salary required.—Box 5060. (5646)

WANTED for employment in various parts of the United Kingdom, personnel experienced in the maintenance and repair of radar and electrical fire control equipment; salary scale £360 p.a. rising to £495, good opportunities for advancement; applicants should furnish full details of age, practical experience, technical qualifications held and in which part of the U.K. they would like to be employed.—Replies should be addressed to D.D.M.E., H.Q. A.A. Command, Stanmore, Middlesex. (5643)

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TECHNICAL sales assistant (male) required for the communications and special products sales division of large, well-known radio manufacturer's export department; aged about 24 years; write giving particulars of previous experience and salary required; good prospects; interesting work.—Box 5802. (5794)

RADIO testers required for work on communication receivers of advanced design, capable of alignment, fault-finding and taking of all necessary measurements.—Write, stating age, experience and salary required, to Box No. 202, R. T. Garland Advertising Service, Ltd., 52, Mount St., London, W.1. (5759)

RADIO television engineer, technically sound, first-rate repairer, directorship offered, car if possible; grand opportunity for right engineer with enterprise, able to take over and develop; radar sub-contracts and other engineering; small capital reqd., also another fair or keen as above; by well-known engineers.—Box 6120. (5654)

RADIO Engineer required by manufacturers of service departments in North London area; applicants should give full details of education, which should not be below School Certificate standard, technical training and experience, age and salary required to Box 425, c/o Era Publicity Ltd., 7, Fitzroy Square, London, W.1. (5799)

A NUMBER of senior and junior vacancies for radio, radar, electronic, television, etc., development, service engineers, draughtsmen, wiremen, testers, inspectors, etc., urgently required 50 television service engineers.—Write in confidence, Technical Employment Agency, 170, Clapham Rd., S.W.9. (Brixton 5407). (5104)

ELECTRICAL inspectors of radio type communication equipment and of television transmission equipment required East London district starting pay yielding £5 15s to £7 per 44 hours 5-day week according to experience and ability; good promotion prospects for capable men. Write stating age and experience to Box 6117. (5847)

DEVELOPMENT department of instrument making firm in London area requires graduate in physics or engineering with good communications experience particularly in acoustics and electronics, including the design of amplifiers for outputs up to 2kw.—Write, stating age, experience and salary required, to Box 5796. (5779)

DEVELOPMENT engineer required for work on a wide range of electronic equipment; applicants must have Degree in electrical engineering, communications or physics, and preferably some industrial experience.—Write stating qualifications and experience to Southern Instruments Ltd., Fernhill, Hawley, Camberley, Surrey. (5774)

JUNIOR engineers for development work on a wide range of electronic work excluding television and radio; applicants should have a good grasp of basic principles of electronic circuitry and some experience of similar work.—Write, stating age, experience and salary required to Cinema-Television, Ltd., Worsley Bridge Rd., Lower Sydenham, S.E.26. (5784)

DRAUGHTSMEN with electronic experience required for senior positions in the electronic drawing office of large manufacturer of radio communication and other allied equipment; applicants should have several years' drawing office experience on similar equipment and a practical background. Please state full details, including age and salary required, to Box 5876. (5807)

RADIO and Television service engineers required in various parts of the country, particularly Coventry, Northampton and Stratford-on-Avon; payment by salary, expenses and bonus; own transport an advantage; applicants must be keen, reasonable and experienced engineers.—Apply in writing to: Service Manager, Sobell Industries, Ltd., Landley Park, Rugby, Bucks. (5800)

THE DE HAVILLAND AIRCRAFT Co., Ltd., have vacancies for electrical draughtsmen, aircraft experience preferred but consideration will be given to those experienced in switchgear and associated components design who can readily adapt themselves to aircraft installation technique.—Apply in writing to Chief Draughtsman, The De Havilland Aircraft Co., Ltd., Hatfield Aerodrome, Herts. (5765)

THE Plessey Company have vacancies in their development division, Ilford, for senior and junior electronic engineers with experience in servo-mechanism design; candidates should be British-born subjects and should possess a good honours degree in physics or electrical engineering.—Write with full details of age, experience and salary required to The Plessey Co., Ltd., Vicarage Lane, Ilford. (5804)

PHYSICISTS, with university degrees, preferably aged 21-28, are required for work in connection with special valves, microwave guides, or microwave circuits, rf/hf high frequency heating; applications giving details of age, experience and qualifications should be sent to the Personnel Officer, Ref. GB/L7, Research Laboratories of The General Electric Co., Ltd., North Wembley, Middlesex. (5804)

DECCA RADAR, Ltd., require a radar circuit engineer for research and development work on receivers; the position offers good opportunities to a man of sound training and experience who wishes to join a firm in which individual ability and energy will be appreciated.—Write only in first instance giving full details age, experience and salary required, to REP. EP5, Decca Radar, Ltd., 1-5, Brixton Rd., S.W.9. (5751)

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DESIGNER draughtsman required for a design and development laboratory; applicants must possess Higher National Certificate or equivalent qualifications, and have a practical experience of plastic moulds, small special purpose machinery, press tool work and general machine tool knowledge.—Apply, stating age, qualifications and experience, to the Employment Officer, Hoover Ltd., Perivale, Greenford, Middx. [5797

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ELECTRONIC engineers are required by a large aircraft company for experimental work on a new and interesting project; applicants, who should preferably be under 35 years of age, must have received technical education up to a degree standard and should be experienced either in U.H.F. design and measuring techniques or in instrumentation work.—Apply, stating age, experience, and salary required, to Box 5063. [5627

MURPHY RADIO, Ltd., require a television service engineer for their Midland Service Depot in Wednesbury, Staffs; duties include answering technical queries and carrying out testing and fault-finding on television receivers; the successful applicant would be required to undergo a period of training in Murphy receivers in Welwyn Garden City.—Applications to Personnel Manager, Murphy Radio, Ltd., Welwyn Garden City, Herts. [5747

TELEVISION service engineers are required by the English Electric Co., Ltd., for London and Birmingham areas; applicants should be qualified service engineers of several years' standing capable of installation, fault finding and maintenance of television receivers.—Write, giving details of age and previous experience, quoting reference 466 to Central Personnel Services, English Electric Co., Ltd., 24-30, Gillingham St., London, S.W.1. [5764

APPLICATIONS invited from technicians (max. age 29) for shore service at W.T. stations overseas; technical and practical experience radio communications essential; applicants should possess first-class P.M.G. and/or C. and G. Radio II Certificates; good salary and allowances; permanency after probation.—Apply in writing, giving full qualifications, experience, to Staff Manager, Cable & Wireless, Ltd., Electra House, Victoria Embankment, London, W.C.2. [5767

RADIO Engineer with experience in technical sales work required by a large company in North London; applicants must have thorough knowledge of modern radio practice with some experience in the aviation field, since the work involves negotiating with all grades of personnel in Government Departments and aviation companies; a university degree is desirable but not essential; applications will be treated in strict confidence, and must state full particulars of experience and salary required.—Box 5790. [5746

ATTRACTIVE staff vacancies for draughtsmen exist at Chelmsford and in London with Marconi's Wireless Telegraph Co., Ltd.; continued expansion of the company's work calls for increased D.O. output and electrical or mechanical draughtsmen; we are invited to apply for these permanent staff positions on the design and development of radio and radar equipment.—Write, giving full details, quoting reference 142A, to Central Personnel Services, English Electric Co., Ltd., 24-30, Gillingham St., London, S.W.1. [5766

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B.B.C. invites applications from engineers or physicists of recognised professional standing for a post in Television Section, Research Department, Kingswood Warren, Surrey. The most have sound knowledge of telecommunications theory and have had practical experience of modern television. Knowledge of up-to-date methods in colour television is essential and experience in the field of vacuum physics would be an advantage; the successful applicant would be required to show considerable initiative and take a leading part in research work in television especially that concerning high definition and colour; the work will include development of experimental monochrome and colour television apparatus and ancillary equipment; salary in grade with annual increments of £50 and maximum of £1,100 per annum.—Applications, stating age, qualifications and experience, to reach Establishment Officer, Ref. 40, Broadcasting House, London, W.1, within seven days. (5860)

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